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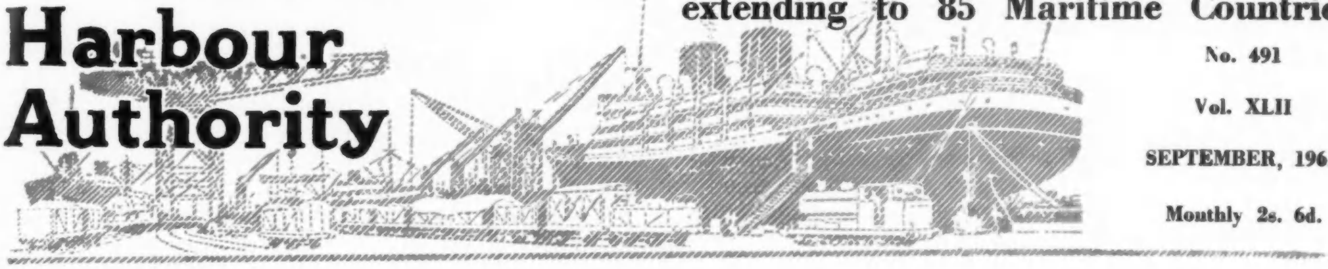


Editorial Notes

No. 4 Berth, Royal Victoria Docks, London

At the conference of the International Cargo Handling Co-ordination Association held in London last May, three Papers were presented dealing with topical subjects of importance to all maritime nations and more especially to those countries who are in process of developing their economies by modernising their ports and transport facilities. The first paper, entitled Shipping and Stowage of General Cargoes was published in our June issue and, in our July number, we gave considerable space to the second which dealt with the development of the "Roadrailer" system.

The third paper, describing No. 4 Berth, Royal Victoria Docks constructed for the United States Lines, aroused considerable interest and in view of the variety of opinions expressed and suggestions put forward during the ensuing discussion, we arranged with Mr. T. E. Cook, the author of the Paper and with Mr. J. A. Fisher, Divisional Engineer of the Royal Group of Docks, to publish an augmented version of the paper giving more details of the engineering difficulties encountered and the reasons for the final choice of a single-storey shed in preference to the two-storey shed which was originally proposed. This point is dealt with in some detail in the article to be found on a following page.

No. 4 Berth, which is one of the 52 berths comprising the Royal Group of Docks, is the largest and most advanced berth in the Port of London and has a great potentiality for the development of mechanical handling and, more particularly, in the use of shed pallets and the technique of dealing with large and heavy containers. This is of some significance as London, which is to such a large extent an overside port, has, in common with many other ports having an extensive lighterage trade, to make provision for the modern trend in the development of container traffic.

During the discussion at the I.C.H.C.A. meeting, a good deal of criticism was made without a full knowledge of all the circumstances involved. The essential feature of any port development scheme is the economic aspect. The present article emphasises the need for collaboration between the port management, the engineers and the stevedoring and commercial interests, when designing new dock facilities, in order to co-ordinate the operating requirements with the engineering considerations. A scheme of the nature envisaged by the United States Lines requires to be carefully examined on the drawing board and fully discussed by all interested parties before any financial commitments are undertaken.

British Ports and the Rochdale Enquiry

The ports of Great Britain are the easy victims of criticism. Members of Parliament, shipowners and traders all at times take part in condemning alleged inadequacies, lack of enterprise, slowness in modernisation and so on. The Parliamentarian has often constituency interests in mind; the shipowner and the trader are, equally, concerned at the expense to which they are put when delays occur. As our Special Correspondent points out in the article appraising U.K. port working, which we print in this issue, it is (perhaps naturally) British docks which are subject to a barrage of complaints. Conditions overseas and at Continental ports may often be just as bad, but probably on the score that what cannot be cured must be endured, the facts are often passed over in silence. The speed of ship turnround in the U.K., for example, even at its worst is far better than in many countries abroad; the imposition by one liner conference after another of surcharges on their tariff rates is almost invariably accompanied by the statement that the excess charges are due to delay caused by congestion in overseas ports, or higher labour costs.

While it is true that modernisation of British ports has not proceeded at the rate which many of their users might desire, thought has to be had to the capital expenditure involved, the fact that finance may not be easily available and the knowledge that increased dock charges will be deplored by the very people who cry out for improvement. It is important, therefore, that a balanced view shall be taken where British docks come under the microscope.

The final report on London docks which is to be submitted to the Rochdale Committee by the London Chamber of Commerce emphasises the short-comings of the Dock Industry. This report naturally deals only with the Port of London but it is reasonable to say that most of the strictures can equally well be directed to Liverpool, Glasgow, Hull, Southampton or elsewhere. The difficulty with an organisation such as a Chamber of Commerce, is that so many of its members have diverse interests closely related to some facets of port working that any strong stricture of some particular feature is bound to conflict with the views of other members. On the other hand, individual entities such as shipowners, stevedores, lighterage companies, etc., are hesitant to voice any severe criticism in case it should rebound to their disadvantage. The shortage of berths is a typical example. Many ports in addition to London have too few unappropriated berths

to which they can assign a vessel requiring a normal discharging berth with shed facilities. All other berths are appropriated to shipping companies who are loth to agree to other vessels using the berth even when they have no ship of their own requiring to use it. In many cases more ships and much greater tonnage could be handled if all appropriations were swept away and allocations of berths were made on a proper basis according to the type of cargo to be handled, the size of the vessel, and the time and date of arrival.

The report of the London Chamber of Commerce proffers as a solution to the constantly recurring labour problems the suggestion that there should be some increase in the number of permanent employees among dock workers generally. They refer to the bad state of relations that exists today between management and men and despite the appreciable improvements which have been made by the introduction of de-casualisation, holidays with pay and pensions, the position shows little improvement.

It has been suggested in some quarters that one solution would be to put the dock workers at the major ports on a permanent working basis. One can imagine the consternation among the employers if this suggestion was taken seriously; most of them would immediately ask "what is going to be done with the surplus men when there is not enough work to go round?" The answer put forward is that the surplus men should be absorbed pro rata to the gangs working. In other words, if 60 gangs were working in a certain sector and there were 120 men surplus, then two men would have to be added to each gang and paid at the same rate as the rest. Conversely, it would have to be agreed that when labour is short the gangs will work short-handed. The chief cause of the troubles in the docks is the lack of goodwill. One cannot entirely blame the labour for this, the men working today have inherited a legacy of bad treatment and poor conditions which has made them highly suspicious of any move made by employers purporting to be in the interest of labour. A plan along the lines suggested would, of course, increase the cost of stevedoring operations on some occasions, but surely the additional cost would be well worth while if the great benefit of goodwill in the Industry should result. Shipowners would more than recoup the additional expense by a quicker turnround of their vessels and merchants would find their goods handled more expeditiously and in better condition if dockers were to be brought to a frame of mind where they regarded themselves as craftsmen with a pride in their work.

Finally, to turn to the Rochdale Committee itself. Is it going to sit, investigating and deliberating, for years as the Devlin Committee and others before it did and, if so, will it have any more effect and will its recommendations carry any more weight than those of its predecessors?

Findings of the Penang Port Inquiry Commission

According to a report published in the August 1961 issue of the Journal of the International Transport Federation, the Commission of Inquiry constituted in June 1960 to report on whether a Wages Council should be established covering employers and workers engaged in stevedoring, cargo handling and lighterage operations at the Port of Penang, Malaya, has now submitted its findings.

After considering the evidence submitted, the Commission arrived at the following conclusions:

(a) While the average port worker's daily rate of pay (mostly calculated on piece rates) is, on the face of it, not out of line with rates in other industries or in Government, the casual nature of the employment has resulted in an irregular and inadequate monthly wage for a large number of port workers;

(b) Evidence disclosed that the agreed daily rates of pay were not always adhered to;

(c) In view of the casual nature of their employment, there is no security for most port workers;

(d) The multiplicity of employers—some with only one lighter or with only a handful of casual labourers, has led to cut-throat competition, thus making it imperative for small employers to rely on casual rather than permanent labour. Such small employers are unlikely to be able to comply with the Workmen's Compensation Ordinance and in such cases insurance policies are seldom taken out;

(e) The multiplicity of unions—none of which is in a position of strength—has made it impossible for port workers to voice their views as a whole. It has consequently not been difficult for certain employers to disregard demands made by unions;

(f) In view of the casual nature of much of the employment only a relatively small number of port workers are able to benefit from the Employees Provident Fund Ordinance;

(g) With a few notable exceptions, negotiating or consultative machinery between employers, or employers' associations, and unions is either absent or largely ineffective.

The Commission in its recommendations states that:

(1) The establishment of a Wages Council would be justifiable if there was agreement that the standard of port workers' wages had been depressed as a result of the lack of machinery for regulating remuneration or conditions of employment.

(2) Where such machinery exists it is inadequate for the maintenance of reasonable wage rates in view of the multiplicity of small employers and the resultant cut-throat competition. A wages council should therefore be constituted which should, however, not cover the Penang Port Commission and the workers represented by the Penang Port Commission Joint Council.

(3) The Wages Council Ordinance should be amended to include lightermen and Taikongs (lighter gang-foremen) within the definition of "workers".

The two members of the Commission representing the port workers, in a minute of dissent, have stated that "unless immediate steps are taken for decasualization and registration of port workers, a Wages Council would be quite meaningless for the great majority of port workers, as casual labourers would not benefit from any Wages Regulations Orders that may be made." They have, therefore, strongly recommended the establishment of a Penang Dock Labour Board.

New Approach to Examining Cargo

It was reported recently in the South African press that a new method of checking ships' cargoes is being tried in Durban with the co-operation of the shipping lines. Instead of tallying the cargo on the shed platform, the cargo is taken from the ship direct into the shed, where it is stacked in double rows with the marks to the outside and subsequently checked in this position.

This new method is claimed to offer the following advantages: (1) Only two checkers are needed to check cargo in the shed. The old method of tallying required a minimum of one tally clerk per crane employed; (2) cargo is discharged more rapidly with the result that cranes and mechanical plant are used to greater advantage; (3) a more accurate check of damaged cargo is possible and this should have the effect of reducing claims against the Administration, thus simplifying the work in the harbour claims section; (4) ships obtain a quicker turnround, an essential factor at ports where periodic congestion is experienced, as is the case at Durban; (5) out-turn reports can be furnished within 24 hours of the ship having completed discharge.

Similar tests were also conducted at Cape Town, Port Elizabeth and East London and although certain teething troubles were experienced, the success of the experiments indicates that the new method is likely to result in increased efficiency and lower working costs.

No. 4 Berth, Royal Victoria Docks, Port of London

New Facility Operated by the United States Lines

By T. E. COOK, Assistant European Operating Manager.

No. 4 Berth, situated on the South Side of the Royal Victoria Dock, just immediately to the West of the Connaught Cutting, is the latest berth to be constructed by the Port of London Authority. It was opened by the American Ambassador, the Right Hon. John Hay Whitney, on April 5th, 1960.

The Berth was designed for the United States Lines to meet the special needs of their trade which, as far as London is concerned, is confined to the United States East Coast Atlantic ports. Four years' planning and building operations resulted in this new construction, the largest shed in the Port of London today. This came to pass largely because of the geography of the site itself and the trade requirements which called for the largest possible transit shed and working area.

To appreciate fully the reason this Shed and Berth came to be constructed of the size and shape it is, one must understand that, at the end of the War, the United States Lines operated only a single storey shed in the Royal Albert Dock, No. 22 on the South Side. This was their appropriated berth, allocated by the Port of London Authority under the Quay and Space Agreement, and was the one which they had used in pre-war days for their regular weekly service between London, Boston and New York.

This shed had a total floor space of 32,400 sq. ft. and it worked reasonably well under pre-war conditions when the circumstances of the trade were different from those prevailing today. In the first place, a much greater proportion of the inward cargo used to go directly overside to consignees' craft and did not require stowage in the shed. It should be noted that a substantial percentage of all cargoes is loaded from or discharged into barges in the Port of London. This is a very important feature of London work, having an historical origin, and stemming from the very wide-flung wharf system existing in the River Thames and the siting of many industrial undertakings on riverside or canal berths in this area. It is estimated that about 70% of all cargo is delivered overside to craft. This, of course, includes bulk grain which is discharged by P.L.A. floating elevators overside to barges.

As far as inward cargo discharged into the shed was concerned, all cargo not claimed within a period of 72 hours after the date of vessel's report at the Custom House was declared "out of time" in regard to freedom from dock charges and removed physically by the Port Authority to another shed in the vicinity. In this connection, it must be understood that cargo on North Atlantic liner services is generally carried on bills of lading which contain the "London clause." This applies to all the traffic brought to London by the United States Lines and it stipulates that the shipowner shall give free delivery of goods claimed within 72 hours of time of ship's report. The consignees of such cargo requiring delivery to road or rail conveyance generally obtain the benefit of a lower schedule of dock charges from the Port Authority.

Under this system pre-war, if the United States Lines' vessel arrived at No. 22 Royal Albert Dock for work first thing on a Monday morning, then on Thursday morning the P.L.A. arrived with road and rail transport to take all the unclaimed cargo away from the shed to warehouse it elsewhere. By this means, the shed was kept clear for the outward cargo which, in the days before pre-entry conditions, used often to arrive on a Thursday or Friday for shipment by the vessel leaving for New York at midnight on the Friday. As will have been appreciated from the earlier remarks, this only applied to cargo received by land—the larger proportion arrived by craft.

In the immediate post-war period, this arrangement became impracticable. In the first place, there was a tremendous upsurge in the volume of cargo moving both ways and the proportion handled through the shed increased to the detriment of the overside cargo. The position at No. 22 Shed, Royal Albert Dock, quickly became hopeless and the Port of London Authority made temporary arrangements for the United States Lines' vessels to be berthed at "D" Shed, Royal Victoria Dock, a much larger shed having a ground floor area of 75,000 sq. ft. with use of a certain amount of space on the floor above—giving a total in all of about 100,000 sq. ft. Even so, the volume of cargo to move in both directions—particularly on the export side—increased every year from 1946 onwards and, in addition, the United States Lines now served six major North American ports instead of just New York and Boston as they did pre-war. The Line was often finding itself with two or three ships requiring berths in the port. "D" Shed was only a single-ship berth, and the Port Authority was continually being asked to allocate an additional discharging berth to the Line.

Early in 1956, consideration was being given to developing a vacant site in the Royal Victoria Docks. This was an unbuilt-upon area known locally as the "Mud Fields Site" which had been used as an open storage ground for heavy logs and similar commodities which did not require protection from the weather. It was shaped roughly like an old-fashioned chopper, laying almost due East to West on the South Side of the Royal Victoria Dock, the handle being a stretch of quay approximately 1,160-ft. by 52-ft. and the blade area approximately 380,000 sq. ft.

United States Lines made an application to the Port of London Authority for consideration in respect of any new development on that site. Shortly afterwards, agreement was reached to construct a new berth and transit shed to meet their requirements on the understanding that, when it was completed, the Line would transfer their operations from "D" Shed to the new installation.

The original ideas of the Line were to have a large transit shed that would incorporate the following:

(1) The shed would be of two-storey construction.
(2) The first floor would be constructed so as to permit not only the operation of forklift trucks and other mechanical equipment but would allow road vehicles to manœuvre thereon.
(3) Ramps would be built leading from the appropriate roadway to enable road vehicles to proceed to and from the first floor.

(4) The ramps and the roadway providing access to the first floor would also provide undercover facilities for road and rail vehicles to be worked on the ground floor.

The Line had in mind a berth now operating in Philadelphia, U.S.A. which does have those facilities, and the idea was that they would have a first floor which would be just as useful and accessible from all points of view as the ground floor.

Certain engineering considerations immediately come into question, and it was soon apparent that such a construction would not only prove considerably more expensive, but would affect the internal transit requirements at ground level.

(a) The two-storey shed would impose very heavy loads on the foundations, and would require a large number of columns. The maximum spacing of these columns would probably be about 50-ft. centres.

(b) This division of the transit shed floor into 50-ft. bays was not desirable in view of the future intention to provide specifically for large containers, which would involve considerable manœuvre of large items of plant.

(c) The concentration of loads by the adoption of a two-storey building would involve a heavy increase in the amount of piling required, and would also affect the type of structure. This alternative structure would probably consist of heavy reinforced concrete or steel beams to carry the loading of the first floor, and in itself, therefore, would impose considerable additional weight.

(d) The site had been filled about 1860 with material obtained from excavations in the Victoria Dock. The remarks of Mr. F. M. G. Pu-Plat-Taylor in the Proceedings of the Institution of Civil Engineers, January 1939, Volume 10, page 319, could conveniently be quoted as follows:

"When he had been at the Victoria Dock in 1905, this filling had been found to be quite unsuitable for carrying any load at all.

The Chief Engineer of the P.L.A. recommended that a shed 700-ft. in length by 200-ft. in width could be constructed with no central columns or stanchions, and that the cost of such a shed would be no greater than the normal convenient design adopted previously by the P.L.A. This shed is illustrated in the accompanying diagrams, and is designed for maximum efficiency combined with minimum weight. The tied arches of 200-ft. span were pre-fabricated in large units, welded together at site and erected complete.

This system enabled the work to be carried out with considerable speed, and as many as four bays were erected in one week. The aluminium sheeting has the advantage of reducing both the weight of the structure, and the amount of maintenance painting.

The general effect of this shed provides not only a pleasing appearance, but also gives excellent working conditions.

The proposal suggested by the United States Lines for a two-storey shed would have involved at least a half-million pounds in additional expense and would not have provided such desirable facility or freedom of movement for container handling. It was largely but not entirely from the financial angle that the two-storey shed plan was dropped.

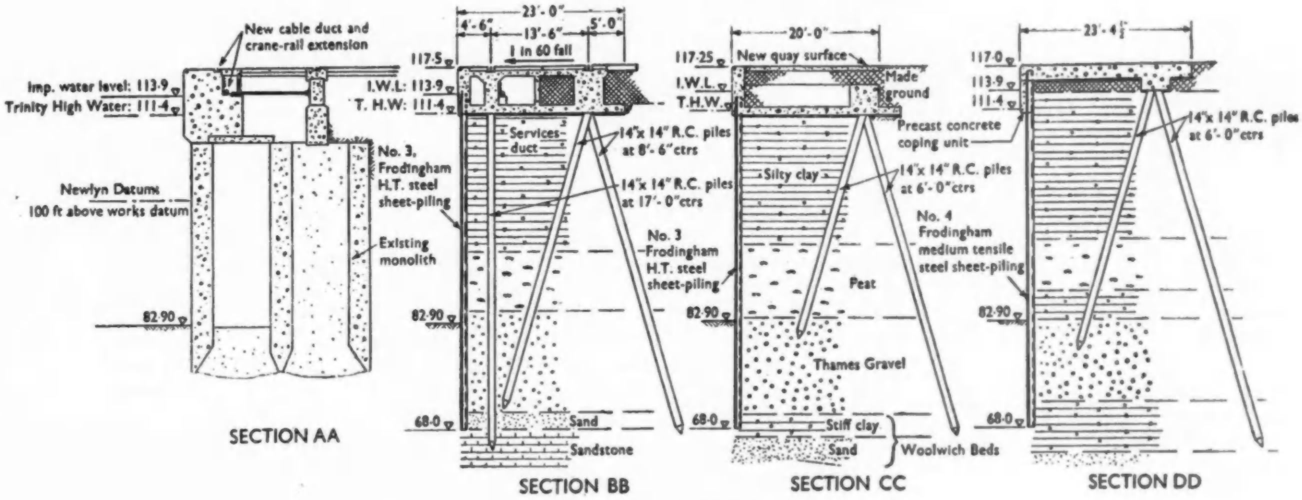
In view of the development of container traffic, it was considered likely that the movement of cargo in containers would probably increase considerably in the comparatively near future and it would, therefore, be prudent to design the new berth with all the facilities to handle containers of varying dimensions and weights. It was, therefore, decided that the quay face and shed floor should be flush, the loading and delivery banks should never be less than 20-ft. wide and all doors should be a minimum of 20-ft. wide and 20-ft. high; access at each end of the shed should have only a gradual slope so that any type of vehicle, forklift truck, straddle carrier or trailer, would be able to negotiate the roadways under load without difficulty.

It was accepted that cargo handling in transit sheds must be dealt with from the floor as overhead equipment is impracticable. If the containers to be dealt with were of greater weight than the maximum capacity of the quay cranes—which are three and five tons—then they would be handled across the quay and through

Aerial view from south east showing United States Lines vessel "American Builder" at berth.

the shed by means of hydraulic-lift platform trucks, straddle carriers, or similar equipment. In this connection, a straddle carrier was specially designed by Messrs. Short Brothers and Harland Ltd. to deal with a large container, 17-ft. in length, of a type which was being used when the berth first opened.

The introduction of the large doorways and the absence of columns enables these large containers to be handled without any difficulty. The transfer of the containers to road or rail has been anticipated by the elimination of any canopy over the rail bank which will permit the operation of mobile or fixed cranes when required. If the time ever does come to deal with a fully containerized vessel or with vessels carrying a large proportion of containers, then it is proposed to install one or more Scotch derricks at the back of the shed for the purpose of loading on to vehicles or unloading them on to the bank. In the event of the container trade being one requiring the emptying or filling of containers at the berth itself, then the containers, either full or empty, could be stacked on the considerable area of hardstanding ground available behind the shed.



TYPICAL QUAY SECTIONS

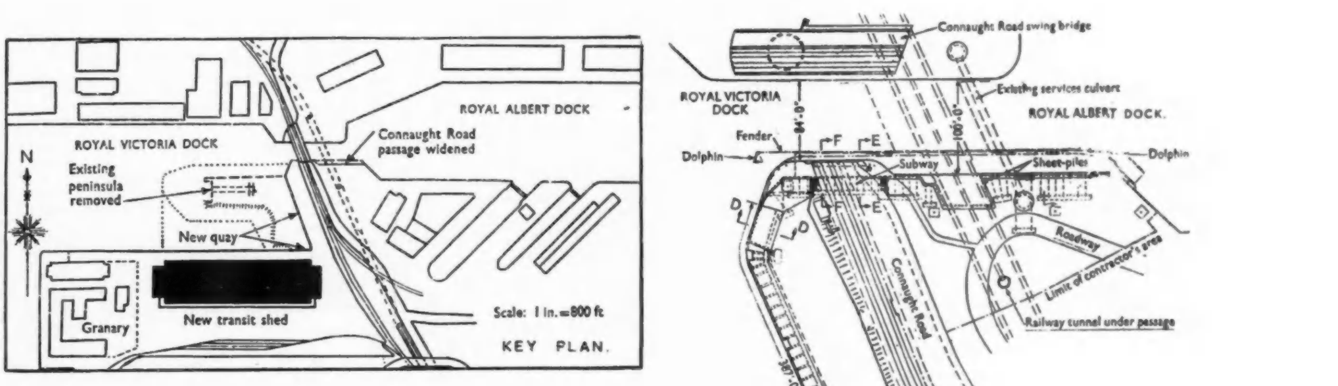


FIG. 1. GENERAL PLAN

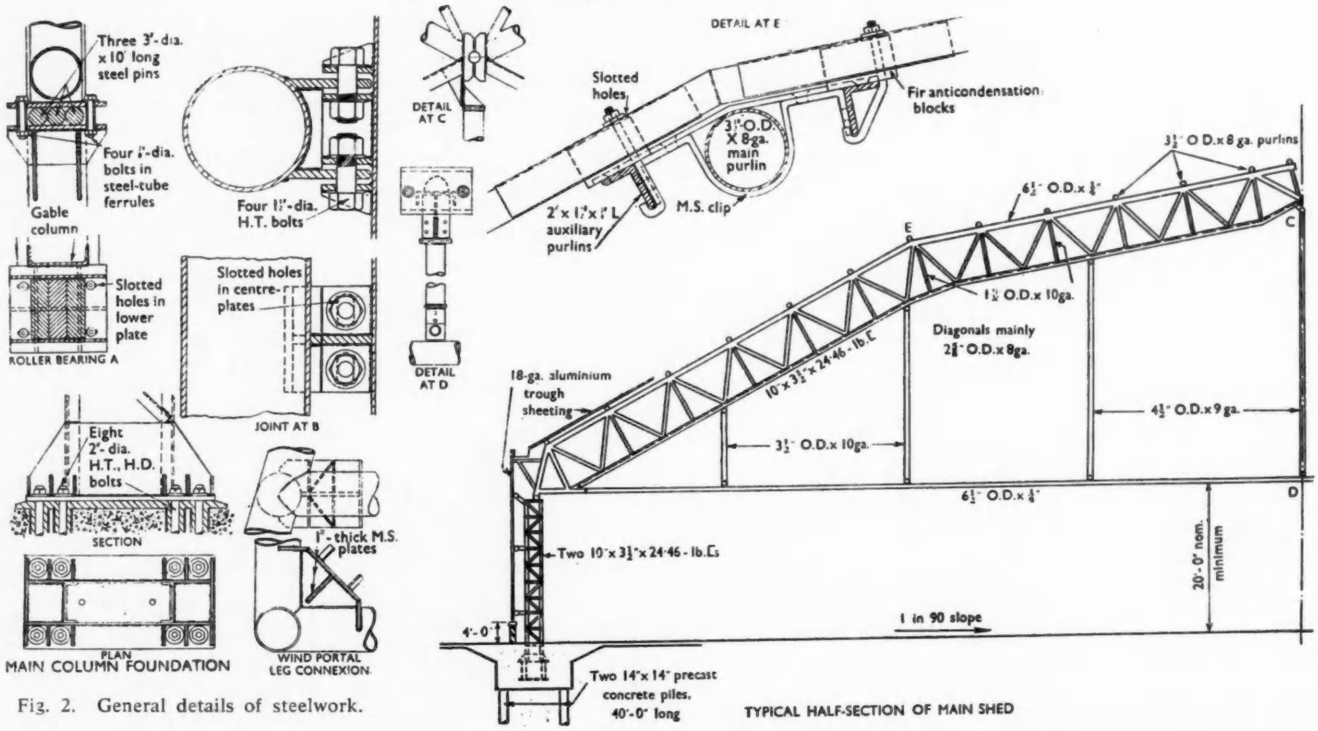


Fig. 2. General details of steelwork.

This handling and disposal of regular container traffic in British ports presents many problems which, failing more exact knowledge of the traffic concerned, cannot be entirely solved at the present time. These include:

(1) The type and variety of cargo to be carried.
(2) Whether or not the containers will be dealt with as through packages and consigned to destination, or received from source, as such, with no handling of their contents at the berth.
(3) The attitude and requirements of H.M. Customs in this matter.
(4) The attitude of dock labour and the formulation of the necessary agreements in operations which inevitably will greatly decrease the time of handling and economize in labour requirements.
(5) The size and weight of the containers used.
There is an obvious limit to size, particularly width and height, of containers going by rail, and there are road restrictions on large packages moving through the streets.
The question of weight is one which affects the type of gear used for loading and discharging and delivery of the packages. As the machines necessary for transporting and dealing with heavy containers are expensive and hard to come by, it is essential to know just what type will be the norm.

The United States Lines are not standing still in this matter and, in the U.S.A., are making many experiments in order to determine what is the best and most suitable type of container, both for reception in America, carriage by their vessels and movement in the U.K. and the Continent. The present view held is that the containers should be able to be transported by detachable bogies on both sides of the Atlantic, and measure about 20-ft. by 8-ft. by 8-ft. with a device for coupling two together in order that, under certain circumstances, a combined length of 40-ft. could be handled.

This type of traffic is going to increase in the trans-Atlantic trade but, as previously mentioned, a large proportion of cargo is received from or goes into barges in the Port of London and, as this method of cargo handling is likely to continue, the type of container used for overside work would obviously be quite a different proposition from the large containers designed for road or rail transport.

Internal view of shed showing "doomey" trucks in foreground.
Note—A doomey truck is a steel platform truck having six wheels in two planes, used by P.L.A. for heavy packages.

Although containers were very much in mind when planning this new construction, a great deal of cargo has to be handled packed in conventional cases, bags, cartons, bales etc. From the plan (Fig. 1) it will be observed that there are no railway lines on the quay face. This is because at this berth comparatively small amounts of cargo are delivered by rail and hardly ever is any cargo discharged direct from ship to rail. It was, therefore, decided that the lines should run at the back of the shed and the tracks be made flush with the road surface to permit road vehicles to operate over them freely.

Two other interesting features are the large canopies, measur-

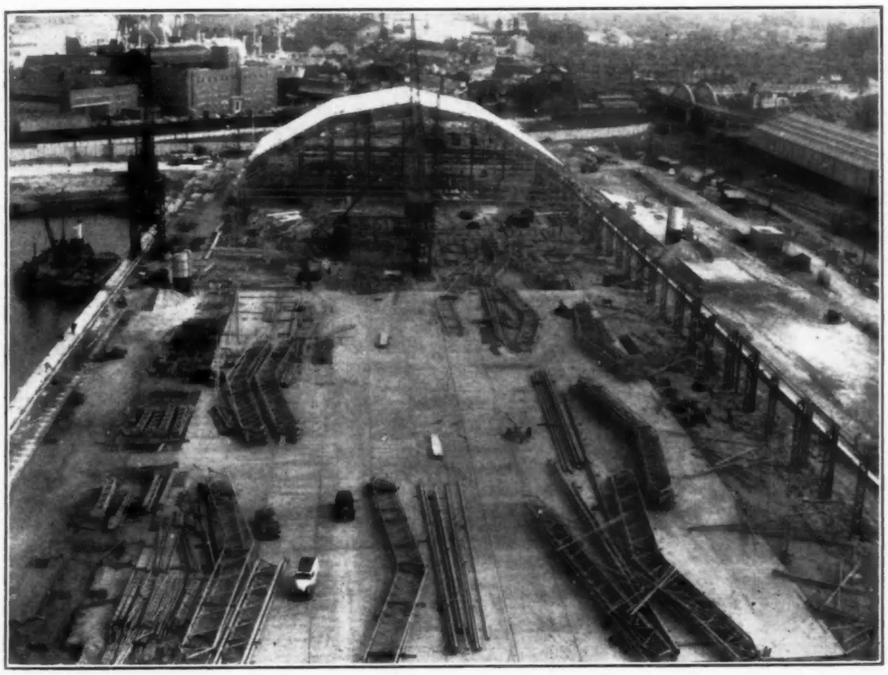
ing 150-ft. by 50-ft., at the Eastern and Western ends of the shed. The object of these is to provide a means to load and discharge vehicles without hindrance from the weather. There is a clear working height under the canopies of 30-ft. to enable mobile cranes of up to three tons capacity to work normal cargo under cover.

The floor of the shed is constructed of 6-in. reinforced concrete and is capable of withstanding a load of 12-cwt. per sq. ft. This is equal to and in excess of the normal load for modern quays. There is a working height of up to 20-ft. in the shed and it is possible to stow higher than that between the horizontal tubular stays which support the very widespan trusses holding the roof.

Such a large and clear floor space lends itself to mechanization and, apart from developments in containerization, it is intended that the berth shall be fully mechanized for both import and export cargo. At present, export cargo is being handled in the conventional manner but, in the near future, a complete change is to be made and this operation will be fully mechanized using fork trucks and pallets. On the import side, all cargo that can be stowed on pallets is now so stowed and delivery, re-stowage etc. is done by forklift trucks. The stage has not yet been reached where the eastbound cargo is all stowed on pallets in the ship's hold and can remain so palletized during discharge and when stowed in the shed. However, this is chiefly due to the type of inward cargo normally handled. In this respect, it should be pointed out that 1,200 to 1,500 tons of cargo might be discharged into the shed from one vessel and that volume could well be covered by six or seven hundred bills of lading. This indicates that there are very few good "runs" of cargo suitable for complete palletization in the hold. Moreover, wherever there are good "runs" these consignments are usually for delivery overside to craft and it would rarely be economic or advantageous to put such cargo on pallets in the ship's hold for barge discharge.

With the present type of ship that the United States Lines are operating—460-ft. in length—two vessels can be berthed simultaneously on the quay, but only one of them is fully opposite the shed; the other is berthed on No. 4a (the "handle" of the "chopper") and has her two first hatches opposite the shed doors and the rest on to the extended quay face. Operations are planned in such a way that the main discharging vessel is on No. 4 Berth itself, opposite the shed, and the second vessel on No. 4a is usually the one discharging a part cargo, often bulk grain or perhaps a large parcel of steel or copper for overside delivery. If this latter vessel should have a small amount of general cargo for the shed, it is trucked along the quay to enter the western end of the shed. Then, on completion of discharge, the vessel moves along the quay to No. 4 Berth to commence loading.

The shed floor is divided into two sections. The eastern end is used to receive exports and the western end imports. However, there are no barriers between the sections and the divisions are quite flexible so that more space can be made available for imports if not required for exports and vice versa. In this connection, it has been found valuable for efficient shed operation and stowage segregation to paint dividing lines on the floor of the shed. In the first place, a 12-ft. roadway is marked out down the middle, parallel to the quay face. This is kept clear of cargo and used solely for means of access by forklift trucks, electric bogies etc. to the various stacks of cargo. Then the shed is divided off with lines running across at right angles to the quay at 50-ft. intervals. The bays so made are lettered and numbered so that the shedmen responsible for bedding-out cargo have a definite location to which they can consign every item for storage.



View from west end of site showing general assembly and erection of steelwork.

Another important asset to the No. 4 Berth installation is the Lighter Quay which runs at right angles to the berth from the eastern end of the site (see Fig. 1) and provides a good quay face of 320-ft. in length by 20-ft. in width where a number of barges can be moored. This is useful for dealing with overside cargo which has to be landed from the ship for sorting and later re-delivered to consignee's craft, and is essential for normal barge delivery operations from the shed. The re-delivery operation can be carried out on the Lighter Quay without interfering with the ship handling activities on the main quay.

Mention has been made of the large amount of open storage ground at the back of the shed which at present is invaluable for assembling automobiles awaiting shipment and for temporary storage of such cargoes as can be safely housed out-of-doors without risk of weather damage and pilferage, for example, drums of oil, bundles of scrap metal and similar items. A large amount of hardstanding is a necessary adjunct to modern sheds and every available square yard has been utilized. In all, a total area of about nine acres was thoroughly rolled with an 8-ton roller and spread with hardcore to provide the standage and paved area. The size of modern road transport requires considerable room in manœuvring and so paved areas have been laid out around the shed to a considerable extent with width up to 70-ft.

Another important feature in connection with No. 4 Berth, which is only at the moment in the project stage, is the "out of time" shed. In explanation, the reader will recall the reference made earlier to the pre-war arrangements whereby cargo that was declared "out of time" in accordance with the London Clause Conditions used to be removed physically by the P.L.A. from the transit shed to another location. For various reasons, cargo from North Atlantic ports does tend to remain in the transit

shed rather longer than is the case in respect of many other trades and, even at No. 4, it does become necessary from time to time for the P.L.A. to remove quantities of cargo remaining on hand unclaimed by consignees. At present, this operation involves both United States Lines and the Port Authority in considerable expense inasmuch as the "out of time" cargo has to be loaded up into railway wagons and transported a distance of more than a mile to warehouse accommodation on the south side of the Royal Victoria Dock. Apart from the feature of the expense involved, much inconvenience is caused to consignees who often wish to claim such cargo while it is in transit and they may be involved in lost journeys. Tentative agreement has, therefore, been reached with the Port of London Authority that a shed will be constructed on the hardstanding ground behind No. 4 Shed (the blade of the chopper) and this shed will be used exclusively to house cargo that has been declared "out of time" and turned over to the P.L.A. for warehousing and delivery. The exact location i.e. whether it will be towards the eastern or western edge of the site, has not yet been fixed and on the chosen site depends, to some extent, the dimensions of the new shed. It is intended that a pre-fabricated type of building will be erected with suitable loading banks. This will be a great boon and a "safety valve" for those occasions when No. 4 Shed appears likely to be congested.

As No. 4 Berth is an island site, being isolated from other cargo berths on this side of the docks, it has to be self-sufficient in all its services. For this reason the P.L.A. and the Lines' Stevedores, Messrs. Scruttons Ltd., have gone to great pains to establish their own facilities for charging electrical equipment on the site and they now have gear stores, hazardous cargo storage space and so forth all within the complex. An extremely valuable asset is a single office block, constructed by the Port Authority, which houses the Steamship Company, H.M. Customs, the Port of London Authority, and the stevedores. This is a great convenience from the point of view of speedy contacts and on-the-spot decisions.

The new No. 4 Berth is one of the busiest in the Port of London today, handling some 198,000 tons of cargo and dealing with 68 ships a year. These figures do not include bulk grain which is discharged overside by means of P.L.A. floating elevators. Operations are virtually continuous and there are few occasions when there is not at least one ship at the berth discharging or loading. The shed is the largest in the port and may well set a pattern for future berth development, particularly in view of the changed nature of cargo handling brought about by the increasing volume of container traffic.

New Ore Loading Pier for Monrovia

The free port of Monrovia in Liberia was first opened to commercial vessels in 1948 and was built by engineers of the United States of America under a $19 million lend-lease agreement made during the second World War. The port consists of a triangular-shaped artificial harbour formed by two long breakwaters extending over a mile into the open sea and providing 750 acres of protected water. Readers of this Journal will recall that a detailed description of the construction works involved was given in the July 1951 issue. At that time the main exports of the port were natural rubber and to a lesser extent iron ore. The development of the iron ore deposits, located 43 miles from the port in the Bomi Hills was then in its infancy but has since increased so that it is estimated that during 1961, iron ore exports alone will exceed 3,000,000 tons.

To facilitate handling the ore it has been decided to build a new ore-loading pier 850-ft. in length, and last July a contract for its construction, together with 12 dolphins, was signed in New York by Vice Admiral Wauchope, USNR (Retd.) president of the Monrovia Port Management Company, which operates the port as managing agent for the Government of Liberia, and by John A. Guissinger, vice-president of Raymond International Liberia Ltd., the contractors.

The pier which will be of all steel construction, has been designed to accommodate vessels of up to 35-ft. draught and will have a maximum loading capacity of approximately 2,500 long tons of natural fines and concentrates per hour, or 1,690 long tons of lump per hour. It will be equipped with a loading tower which will move along a track to line up opposite the holds of the ore vessels waiting to be loaded. A continuous belt, two miles long, will run from the loading tower to the ore discharging facilities on shore where rail trucks will dump their loads directly on to the belt. Loading will be carried out from either side of the pier.

Six dolphins, each constructed of steel piles sunk vertically into the harbour bed, will be located on each side of the pier, and will hold the vessels several feet from the pier during loading. All steelwork on the pier and the dolphins will be cathodic-protected against corrosion.

Dredging operations carried out in the harbour during the last twelve months have increased the depth of the turning basin from 30-ft. to 35-ft.

The estimated cost of the new construction works is $1,400,000 and the Port Management Company and the Liberia Mining Company are co-operating with Raymond International who are furnishing all engineering and supervisory personnel, labour, tools and machinery. When the work is completed in January 1962, some 850-ft. of the present wharf space will be freed for handling dry cargo vessels so that a total of 2,000-ft. of berthing space will be available for general cargo.

The ore pier is being constructed for the Liberia Mining Company which shipped its first ton of ore in 1951 and is still the only producer in the country. A substantial shareholding in this company is owned by the Republic Steel Corporation. However, another ore pier is now under construction at the port for the National Iron Ore Company Ltd. and it is expected that this will be ready for operation shortly to handle the company's ore deposits which are about to come into production at Mano River.

Further Improvements to the Port

In addition to the new ore handling facilities, a petroleum pier is also under construction and is expected to be completed by December of this year. Projecting into the harbour from the south breakwater, it will be capable of accommodating tankers up to 35-ft. draught.

The Free Port of Monrovia is equipped with modern transit and storage sheds, a wide variety of cargo handling equipment, fresh water supplies, standby electric power plants and fire protection services. During 1961 it has placed orders worth nearly $250,000 for cargo handling equipment, including heavy lift cranes.

Latex tanks are also operated by the Port Company for the storage of latex awaiting export. At present the Company employs some 1,350 persons, more than 95% of whom are Liberians. Last year a total of 1,084 cargo vessels and coasters visited the port representing flags of 18 nations and carrying 400,000 tons of cargo. Another 234 ore and petroleum ships accounted for 3,118,500 tons, and it is expected that by 1965 the total of iron ore shipments will exceed 10 million tons.

An Appraisal of U.K. Port Working

What is Wrong with Present Methods?

by a Special Correspondent

This article analyses criticisms frequently made about the alleged lack of enterprise and operational facilities in the ports of Great Britain and reviews suggested remedies.

The British, as a race, are prone to exaggerate as well as to understate. Whereas other nations do not publicise more than they can help unpleasant facts (about their weather, for example, or about their industrial troubles) the Briton often seems to revel in broadcasting gloom, as if the sun never shone in these islands and no industry would be able to carry on much longer because of strikes and disputes.

Periodically the docks of Great Britain come under a spate of criticism—some of it justified, much of it not. In pointing out, however, the mote in the British eye, it is often forgotten that there is a beam in the foreigner's. Comparisons between Continental and British ports, for example, are often unfair, for like is not being matched with like. A number of Continental ports are modern simply because they were destroyed in the war and have since been rebuilt. Figures about ship turn-round can be as deceptive as any set of statistics compiled for a special purpose; the best abroad is not always set against the best in Britain—and so on.

What follows, therefore, should be read in the above context. The fact that British docks are being subjected to a thorough investigation should be regarded as an earnest of the desire of everyone concerned—Government, port authorities and shipowners—to see that they are brought to the highest state of efficiency.

Not infrequently—because, unfortunately, the disputes themselves are not infrequent—the criticisms about British docks correspond with an outburst of troubles, major or minor, affecting labour. In recent months there has been comment, some of it stringent and all of it severe, about the adequacy of the country's system of docks and it has coincided with unofficial strikes affecting Britain's principal port, London, and stoppages in other places such as Avonmouth.

Thus the appointment by the Minister of Transport of a special committee under Lord Rochdale to inquire into the adequacy or otherwise of Britain's docks and harbours is timely. It is to be "all-embracing" so far as efficiency of the ports is concerned. It will consider to what extent the ports are adequate to meet the present and future national needs; whether the methods of working can be improved; and what recommendations can be made. According to the Minister of Transport the committee will be able to look at almost anything from management to labour, equipment and finance and Lord Rochdale himself has stated that he accepted the chairmanship because be recognises how "enormously important" efficiency in the ports is to the country and its industries, and more than ever so when considered in relation to the present export drive.

The stage is therefore set for what all will hope will be a thorough and intensive examination of the difficulties of dock operation and management—whether efficiency is conditioned by financial considerations; whether modern methods of cargo-handling are matched as between dock and ship; whether the smaller ports offer as good facilities as do the larger and trade should be encouraged there; whether the labour problem is indeed insoluble; whether, in fact, "the fault, dear Brutus, lies with us . . . . . ." depending on who happens to be "us".

Let us look at some of the criticisms which have been advanced during the last few months. They come from many different quarters, not all directly associated with shipping. This is what Sir Donald Anderson, the chairman of the P. & O.-Orient group has to say:

"The business of the Port (of London) has grown over the years, but its capacity to handle the business has not matched the growth. The number of berths required depends to some extent on the rate of work achieved. If the rate of work were to increase, the same number of berths could handle more cargo. But there is no reason to expect a rate of work so much higher as to relieve berth congestion, and more berths are now urgently needed.

"Since the war vast improvements and great additions have been made to the capacity of the continental ports, competitive with London for certain trades. At Rotterdam some 38 new berths have been created and, indeed, in addition, a new port, Europoort, has been built. At Antwerp there has been a great expansion of berths, with more to come. In London on the other hand, the enormous amount of work done by the Port of London Authority since the end of the war and done, too often, in the face of shortages both financial and material, has been confined almost entirely to the restitution of war damage and the remodelling of ancient berths. There has been no expansion. Indeed no new dock system has been built for 40 years. It is difficult to escape the conclusion that London is risking the loss of its share of the greatly increased trade of the world.

"It takes years before additional berths can be provided, and it is high time that a start should be made. Suitable land is available at Tilbury and if the provision of finance is an obstacle, or if the Port of London Authority should be unable to see a commercial return on the money to be invested, it would surely not be unreasonable to suggest that the Government, which puts up whatever money is needed for airports, should, if necessary, do the same for seaports, which carry the vast preponderence of the trade of this country and which, if cramped, must limit this trade."

These observations were made, of course, before the announcement by the P.L.A. of their £20m. expansion scheme at Tilbury, which will almost double the capacity there. Sir Donald might almost have been speaking with prevision. Reference to the development scheme will be made later in this article.

In Liverpool the complaints against the dock authority take a different course. The Mersey Docks and Harbour Board are praised for making the Liverpool and Birkenhead docks in particular "the most efficient (according to Mr. G. V. Corlett) in the United Kingdom, if not in the world." but they are warned not to "outprice" the port. It is admitted that their ventures need initial capital and maintenance cover, but it is urged that charges for master porterage, quay rents, cargo-watching, etc., are made to carry an unduly heavy share of the burden in finding the necessary funds. Even now, it is said, an increasing number of the final buyers in some trades are asking that their produce should be shipped to ports other than Liverpool in spite of the fact that the actual delivery of the goods may take somewhat longer.

Take the matter of timber discharge at Liverpool. It is con-

tended by Mr. H. Gordon Craig that the reorganisation of one dock so that there could be an appropriated berth for timber which could be discharged direct to rail or motor and sorted away from the quay would more than double the rate of discharge, thereby reducing costs, including the cost of freight. The example set by the British Transport Commission at Garston Docks is quoted. Since 1956, says Mr. Gordon Craig, the dock authority has embarked on a vast modernisation scheme in an endeavour to provide the most modern facilities for the expeditious handling of cargo and the speedy turn round of ships. A large section of the work was completed in 1960 and the results from modern cranes and quays, which permit discharge from ship to road vehicle, are now being seen.

In the west, however, the British Transport Commission do not fare so well at the hands of their customers. Mr. J. A. Fairweather agrees that much has been said about the port of Cardiff and not without justification, for a lot would have to be done before it once again reached some degree of prosperity. The City Council, through its City Development Committee was playing its part, for it appreciated the importance of securing more industry that would be beneficial to the traffic of the docks. It was true that the trade figures for 1960 showed a satisfactory improvement over 1959, but they flattered to deceive, for the port failed to obtain its proportion of the increased trade of the South Wales ports. They could not do otherwise until dock charges were no more than those at competing ports.

The Iron and Steel Board also come into the picture. They point out that four of the ports used for dispatching ore to this country can at the moment accept ships of 30,000 tons or more. The main limitations, however, are at some of the most important discharging ports in this country. Port Talbot, for example, and some of the North-west coast ports, except on certain tides, can dock only 10,000-ton carriers.

Nearly 50 per cent of the United Kingdom's ore imports in 1965 are expected to come from overseas ports which can load ships of over 28,000 tons. Only 15 per cent, however, will be received at ports in the United Kingdom of this capacity. A further 40 per cent will be received at ports able to take over 18,000 tons and up to 28,000 tons. The position would be improved if Newport and Middlesbrough could, as is possible, be expanded to take 30,000-ton ships, and ships of this size would then be able to unload at ports accounting for over 35 per cent of the United Kingdom imports of ore.

Where tankers are concerned, a Member of Parliament recently asked the Minister of Transport if he was aware that the tanker "Naess Sovereign" of 88,500 tons deadweight, registered in London, entered service this year and a sistership of the same size was to be launched in October. Which ports in the country were capable of receiving these vessels through their entrance locks? The reply was that these and still bigger vessels could be received at two ports in this country. The member argued that there were two ships being constructed with a beam of 122-ft. and there was no port in Great Britain that could take them—a reflection on the greatest maritime country in the world. The Minister of Transport repeated that there were two ports that could take these vessels.

And what of the labour situation? Relations in an essentially casual industry like dock work are tinged by the unhappy traditions of the past. The Dock labour scheme has not been a complete success. Friction is caused by the size of the register —too small to cope with peak periods; too large when work is slack. When there is labour shortage work gets held up; when activity temporarily dies down the old fear of redundancy comes into play.

The result is restrictive practices, opposition to the introduction of labour-saving appliances and resistance to the very means of ensuring the future prosperity of the ports. This, in turn, makes co-operation between management and workers more and more difficult, particularly as the relationship between the two is inevitably somewhat remote. The docks need to be expanded and modernised, but the money spent must be productive and not frittered away on an inflated dock register. How is the vicious circle to be broken?

In 1960 dock disputes involved the total loss of 245,813 man-days. This represents the loss of potential labour by men directly involved, but in the case of the tally clerks' strike in London, when 32,904 man-days were contributed to the total, far greater numbers of other registered dock workers were unable to work. Although, as Lord Ebbisham points out, interruptions or delays at the docks undermine more immediately and dangerously the whole structure of our export—and import—trade than strikes in any other field, all unofficial strikes are a serious threat, for uncertainty over delivery is regarded very unfavourably by customers overseas and a bad reputation in this respect is highly damaging.

Should unofficial strikes be made illegal? One shipyard director, Mr. A. H. Lewis, thinks so. The whole country, he said recently, will have to take stock and ask the Government to look at the problem of unofficial strikes. They are completely unnecessary and the disputes could quite easily be settled by industry through official channels. But this may be treading on dangerous ground. If unofficial strikes were outlawed, how long would it be before some aggrieved interests demanded that official strikes also should be declared unlawful?

Or does the solution of the problem lie in a more balanced dock labour force? This, in the view of Mr. A. J. M. M. Crichton, the chairman of the National Association of Port Employers, would assist the solution of many of the present-day troubles. If it could be achieved a host of difficulties, he asserts, would disappear overnight. Labour is not in excess, but short, and skilled labour is terribly short. Efficiency in the port transport industry can be improved by a greater measure of mechanisation, not for mechanisation's sake alone, but by mechanisation that is practical, possible and sensible.

Mr. Crichton's views are worthy of consideration. He would reduce the gangs and raise the dockers' wages. The non-casual percentage of the labour force could be raised, he says, from 50 per cent to 75 or 80 per cent of the total. With the compulsory retirement of old men, the outflow and therefore the intake of men in the industry is under control. No question of redundancy arises. This country, says Mr. Crichton, placed as it is, will thrive when transport revives and won't revive until it does.

But Labour has to be persuaded of this and with the prospect of the Common Market looming up and the fears, largely imaginary, no doubt, of Britain being flooded with cheap Continental labour if she becomes a member, the outlook is not too promising.

Mr. Geoffrey Milling, who has just retired from the chairmanship of the London General Shipowners' Society, has expressed the hope that the question of night work or shift work in the Port of London will receive the careful consideration of the Rochdale Committee. He believes that eventually this will have to be introduced in some form to facilitate the quicker turn-round of vessels, more continuous employment of valuable port equipment and the consequent accelerated flow of cargo through the port.

The society does not have any direct dealings with dock labour, as the necessary shipowners' organisations are set up for that purpose. It is, however, much concerned with the maintenance and improvement of the port's facilities and is continually making representations for their betterment. It is also making a careful study of the ways in which port operations can be improved and it is hoped that there will be an opportunity of presenting its findings to the Rochdale committee.

What is the point of view of the traders? The London Chamber of Commerce has submitted several recommendations to the Rochdale committee; the major of these is for a reappraisal of the dock labour scheme. The Chamber contends that labour relations in London docks are unsatisfactory and emphasises that most of the grounds for complaint by users of the docks would vanish if labour co-operated more fully by adapting its practices to the needs of modern methods.

The plain fact, says the report, is that the dock labour scheme is not working satisfactorily from the user's point of view, and has continually failed to prevent unofficial stoppages in the five years since the Devlin Committee endorsed its constitution. While not submitting any specific alternatives to the scheme, the Chamber draws the attention of the Rochdale Committee to the proposals put forward by the Timber Trade Federation at Lord Forster's inquiry in February for the docks to be run by a body consisting of employers' representatives only. This idea was rejected by the Devlin Committee and by Lord Forster, but the Chamber says that many port users agree that satisfactory labour relations and port discipline are not encouraged by the existing scheme.

Several members of the Chamber urged outright that unofficial strikes should be made illegal. The Chamber points out that this suggestion is submitted merely to illustrate the acute exasperation of port users and their conviction that unofficial stoppages represent a threat to the whole nation's wellbeing. The Chamber is not prepared to support any suggestion which would adversely affect the welfare of the dock workers; it believes that their stability of employment and status should be further raised, always providing that these advances are accompanied by increased efficiency and freedom from interruption.

The Chamber feels that not enough attention is being given either by employers or official union representatives to ensuring that individual dock workers are aware of the importance of their work to the trade of the country. Some members feel that it might be valuable if there were some contact between port users and dock workers so that each could gather some understanding of the other's problems.

Here it may be observed that, like other well-intentioned ideas, the difficulty is to put it into practical effect. There is already criticism that the dockers and their employers have no personal relationship—often the docker does not know for whom he is actually working—how much more difficult, therefore, the bringing together of port users and port workers. But a problem should present a challenge.

Finally, the London Chamber of Commerce suggests that the Port of London Authority should be asked to produce a comprehensive plan for the port embodying all that should be done to meet present and future demands of trade and industry in the port and that the Government should decide in the national interest which of the projects merits financial assistance. It mentions particularly the need for more berths, a greater use of mechanical handling equipment and an improvement in the number of larger quayside cranes and floating cranes.

This submission was made, of course, before the P.L.A. announced its £20m. scheme at Tilbury, which will embody a completely new general cargo dock over a mile long, to be constructed on waste land owned by the authority to the west of the existing cargo berths in Tilbury docks. This will be the first new general cargo dock in Britain since before the war, and the biggest since the King George V Dock in London and the Gladstone Dock in Liverpool.

The work will not begin for about two years and will, of course take several years to complete. It will entail, amongst other things, the re-routeing of road and rail connections and should be of great benefit in reducing congestion and accelerating import and export cargoes through the port of London as a whole. The opportunity presents itself of planning facilities of the kind which as a rule British ports lack.

"Aye, but there's the rub," as Hamlet said. How is a new dock to be planned? Should it be designed to fit the ship, or should shipowners be expected to provide the ship that will fit the dock? The life of a ship is some twenty years; it is then usually scrapped and a successor, improved and modernised, takes her place. But the life of a dock extends far beyond that; it cannot be scrapped and renewed even every hundred years.

Let us call in evidence two shipowners on the ship of the future and cargo-handling problems. Sir Nicholas Cayzer, the chairman of the British & Commonwealth Company, who is keen on research, doubts whether the resources of British yards are capable of building the ship of the future. He holds the view that if a basic design could be evolved suitable for a trade, or a section of trade, it should be possible jointly to plan an order for a reasonable number of ships of this particular class with considerable savings, for the shipbuilder could plan a flow of work and could adopt many of the techniques of mass production.

It will be observed that Sir Nicholas is advocating building ships for a particular trade and he uses the analogy of competitors joining together to operate liner services. Clearly the expectation is that the docks should provide the facilities the shipowner requires, not that the ships should be specially designed to match the equipment of the docks. He emphasises that a ship is only earning money when it is at sea and that every additional day spent in port thus represents one day's loss of earning capacity.

He believes that economies can be effected in the docks. Some perhaps need only a change of attitude to the use of mechanical aids; others a much more radical re-arrangement. Dock areas and the docks themselves are largely the result of piecemeal development. With few notable exceptions there is inevitable congestion—of goods moving into and from the docks, and just as inevitably lack of progress in achieving a quick turn-round of those "ever more expensive units which ply for hire on the sea routes of the world."

Lord Runciman sees the need for a radical change in the handling of general cargo if the shipping industry is to continue to provide its principal service to mankind. He believes that the movement of cargo into and out of ships will be the greatest single problem in ship design and operation which this generation will have to face. Naval architects can claim, he asserts, that they have gone a long way in solving the major problems of purely technical design and he thinks it is unlikely that in naval architecture and construction there will be any major break-through during this generation.

Ten years ago, Mr. Basil Sanderson, as he then was, read a paper on "Britain's deep-sea liner trade" and Lord Runciman recalls that in the course of that paper Mr. Sanderson asked whether in ship design some alteration in conception might be possible and which might lead to some economy as opposed to the present system. Side-loading doors and the elimination of masts and funnels would, for example, enable ships to load and unload at covered berths. Since that paper was read there have been notable improvements, especially in the loading and discharging of bulk cargoes; there have been, too, what Lord Runciman calls "nibbling" at the problems of general cargo, but they have been of limited application.

Lord Runciman recently made a calculation of a ship's operations on the North Atlantic which showed that putting the cargo into the ship and taking it out at the other end cost more than all the remaining expenses of the voyage—fuel, wages, stores and even depreciation. That is a startling conclusion, as is the fact, also vouched for by Lord Runciman, that a liner on

U.K. Port Working—continued

a regular run often spends no more than 70 days a year at sea, the remainder of the time being occupied either waiting for a berth or in using out-moded methods of loading and unloading cargo. From the point of view of the shipowner dealing with general cargo there is not, he declares, a port in the world which can justifiably claim to be adequate to deal with present-day requirements.

It is a disturbing indictment and it will be noted that it applies not particularly to the ports of this country, but to those all over the world. Some, of course, will be better than others, but the general pattern is the same, in spite of the bright exceptions.

Shipowners are thinking ahead. To Sir Nicholas Cayzer, already quoted, the "containerisation" of cargo seems logical. How much easier it is to handle one container holding a number of small articles than that each article should be packed separately in the hold of the ship! Would any furniture remover, he asks, attempt to fit each household article, as such, into his van? He sends his packers in advance to assemble in cases everything so containable.

However, to be effective containerisation requires not only ships specially constructed to handle this type of traffic, but fairly large areas in close proximity to docks so that export goods may flow naturally into their respective containers and imported goods can be quickly cleared to their final destination. Sir Nicholas thinks that the Rochdale committee may well have attention focused on this matter and that action may follow.

It was recently announced that a shipyard would be able to build in future a ship of 200,000 tons. Few will suppose that that is in immediate prospect, although a few years ago 100,000 tons seemed a fantastic size to contemplate. But if a 200,000-ton ship should ever be constructed in this country, what dock could receive it? It may be argued that, in the same way that shipowners cannot plan their fleets for "peak" demands, so port authorities cannot contemplate providing accommodation for ocean monsters which may be few and far between. Could it be argued that the space occupied by one 200,000-tonner could accommodate four 50,000-ton vessels? That is for the pundits to consider.

If in the course of this article attention should seem to have been concentrated on London, it is perhaps inevitable that the biggest dock system in the country should occupy the limelight. Two fairly recent strikes have brought the labour situation into high relief, but it must not be forgotten that other docks in Britain have also been involved in disputes. The tally clerks' unofficial strike was a London affair, but over 118,000 man-days were lost in London, Liverpool, Birkenhead, Garston and Manchester on various dates between June 20 and August 23 owing to dissatisfaction with the progress of a national wage claim.

In Hull nearly 36,000 man-days were lost when there was a further dispute over the traditional scoop-and-basket method of unloading cotton seed. This port was also the scene of two one-day token stoppages in November and December in protest against the number of weekly workers in relation to the size of the register. In other ports, too, there have been stoppages, many of them for what most people would call trivial reasons and certainly of a nature lending themselves to negotiation.

Bad labour relations, inadequate capacity, sometimes imperfect management—these are some of the problems of the docks here and abroad. The newer Continental ports offer serious competition to those in this country. Bigger and faster ships will demand more spacious quays, sheds and transit and handling areas. Rail and road facilities need to be improved; indeed, it may well prove that in the end the inquiry as to what is wrong with the docks should start at the factory and end at the port.

A Protected Anchorage in Milford Haven

A new jetty and pier head near Hubberston Point being built for the Milford Haven Conservancy Board will be completed later this year. It will provide protected anchorage for the Board's pilot and other small vessels.

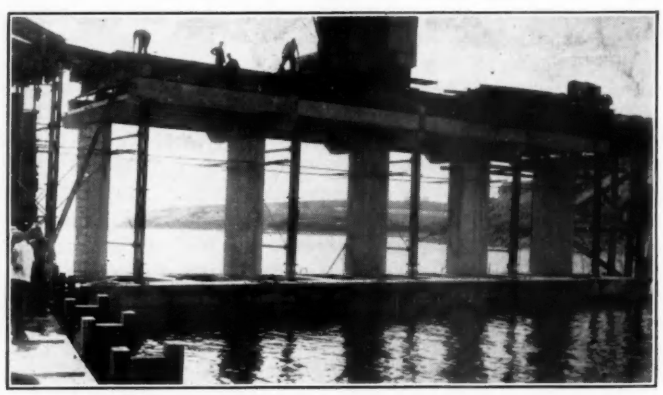
The approach jetty, some 300-ft. long, is of simple economical construction using reinforced concrete piles and precast beams and soffit slabs, with in situ concrete topping.

For the pier head, 340-ft. long, an interesting new technique is being employed. The foundation is formed of three reinforced concrete pontoons, each 120-ft. long overall by 22-ft. wide and

Pontoon being towed into position with approach jetty and one leg of pier head on right.

16-ft. deep and weighing approximately 1,000 tons. These pontoons, or foundation units, are being pre-fabricated in the Milford Haven Dock Company's dry dock and floated out and sunk in position at the end of the approach jetty. The pontoons are pinned to the sea bed by piles driven through leading-slots incorporated in them. The decks of the sunken pontoons are at mean tide level, thus providing a working platform, a foundation for the pier head superstructure and a protecting mole below mean tide level.

The superstructure of the pier head consists mainly of pre-cast concrete units. The space between the pontoon deck and the pier deck will be covered with steel sheet piles attached to the structure, thus forming a breakwater at all tide levels and pro-



Pier head under construction showing pontoon and superstructure.

viding a protected anchorage. The whole length of the steel piles will be accessible for maintenance. Access to water level will be by hinged bridge on to a floating stage.

The total cost will be approximately £150,000.

The consulting engineers are Posford, Pavry and Partners of Westminster, a member of the Association of Consulting Engineers and the contractors are Peter Lind and Co. Ltd. of London.

New Device for Handling Ships' Cargo

The Algonquin loading/unloading equipment for cargo ships represents a decisive step forward in the application of research and mechanisation to cargo handling. The development work was undertaken mainly by Messrs. Clarke, Chapman and Co. Ltd. and MacGregor International who collaborated with other interests.

The new equipment is now available with capacities from 200 to 500 tons per hour, and can be fitted to new or existing ships regardless of type. In addition to its use with bulk cargoes, it can be adapted to handle containers, palletised or general cargo, the main feature of the machine being the provision of a telescopic conveyor which will discharge at any point between 10-ft. and 100-ft. from the ship's side. This conveyor is supplied from a vibratory feeder capable of transporting semi-solid materials such as coal, ore or powders on an upward gradient. This type of feeder is finding increasing application ashore but hitherto it has been adopted to a very limited extent on board ship. Cargo taken from the hold can be traversed athwartships and discharged over the side or into a collapsible steel hopper on the bridge structure, where the vibrator will feed the material on to the conveyor for discharge ashore. The conveyor and its structure are detached from the bridge for stowage on deck.

The whole equipment has been designed to stow so that it gives a minimum of topweight and top hamper; furthermore, as it weighs no more than orthodox cargo gear, there is no loss in deadweight. When stowed on the upper deck there is no loss in cubic capacity and when loading or discharge is undertaken by shore-based equipment, it does not hinder these operations. Indeed it can be used in conjunction with the shore handling equipment, thus speeding the operations and maintaining a satisfactory trim. It can also be used to shift cargo between holds after loading.

A Priestman's "Walking Type" Grab is often used for bulk cargoes so that the cargo can be recovered from sections of the hold remote from the hatch without the use of bulldozers. Grain, sugar, salt, bauxite, alumina, iron ore, coal, phosphate, gypsum and even scrap iron, can be loaded from or into trucks, railway wagons or barges, while those products, such as alumina, phosphates and fertilizers, which are affected by water, can be loaded or discharged in wet weather, as the whole equipment can be covered with a canvas awning.

The equipment can be operated by one man, and its low power consumption usually allows installation without any increase in the generator capacity fitted in the ship.

All mechanical and electrical equipment is of the totally enclosed marine type both to meet the exacting practical, technical and engineering requirements and because it is destined to be stowed in an exposed position on deck.

In order to ensure reliability and to avoid complex gearing and transmission problems, each of the main operations, i.e. holding, closing and traversing, are operated by a separate electric motor; but the auxiliary operations, such as bridge-lifting and travelling, are carried out from a common electro-hydraulic system. The bridge is a self-contained unit and all the control gear is mounted on the bridge itself, or in the driver's cabin. This cabin is mounted with the mechanism for the traversing grab, ensuring that the driver always has an uninterrupted view of the load.

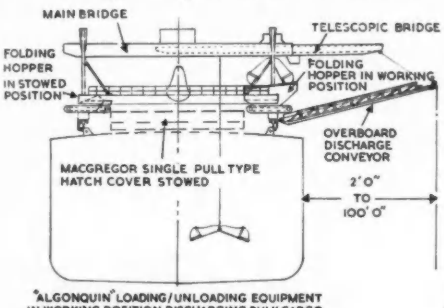
The traversing, holding and closing gear trains are mounted on ball or roller bearings and totally enclosed in cast oiltight gearcases. The electric motors are connected to the gear trains through flexible couplings. The grab is traversed by wire rope along the telescopic girder, which is, in its turn, mounted on wheels.

The bridge which is driven from the hydraulic system, is designed to travel the full length of the ship's hold spaces when fully loaded, but normally it will only be used for travelling from hold to hold.

The equipment fulfils the requirements of the Board of Trade, the British Ministry of Transport, Home Office and Factory Acts, the Institution of Electrical Engineers, Lloyds Register and the other classification societies, and all materials are to British Standard specifications.

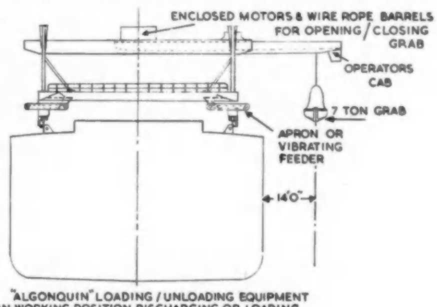
Container traffic is growing in popularity and in order to handle bulky containers a special type of shipboard mounted gantry crane was devised. Recent experience with such vessels has shown that with this innovation a vessel of 7,000/10,000 D.W.T. can be loaded or discharged within 60 to 70 hours, where before it took over a week. The manufacturers have therefore developed this equipment so that any type of container or pallet can be handled as well as dry bulk cargoes.

It is claimed that with this equipment a bulk carrier can be converted into a vessel capable of handling any type of cargo at a speed superior to a burtoning system or that attained by mounted cargo cranes.

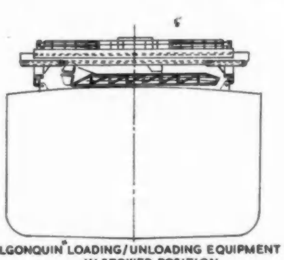


"ALGONQUIN" LOADING/UNLOADING EQUIPMENT IN WORKING POSITION DISCHARGING BULK CARGO VIA OVERBOARD DISCHARGE CONVEYOR DISCHARGE CAPACITY 500 TONS/HR.

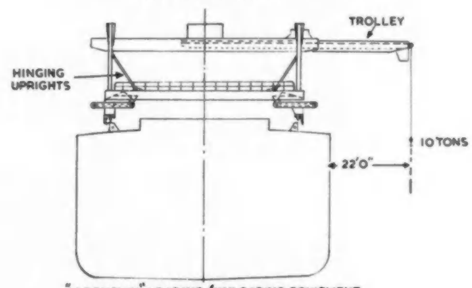
OTHER CAPACITIES ALSO AVAILABLE.



"ALGONQUIN" LOADING / UNLOADING EQUIPMENT IN WORKING POSITION DISCHARGING OR LOADING BULK CARGO VIA GRAB.



"ALGONQUIN" LOADING/UNLOADING EQUIPMENT IN STOWED POSITION.



"ALGONQUIN" LOADING/UNLOADING EQUIPMENT ARRANGED FOR LOADING PALLETIZED OR OR CONTAINERISED CARGO.

Improved Harbour Equipment for the Tyne

The Tyne Improvement Commission are this month installing a powerful electric light of 1,340,000 candlepower on the North Pier Lighthouse at the harbour entrance. This will give a tenfold increase in beam intensity over the previous apparatus.

The Commission is also testing and hopes to bring into full operation shortly an ingenious method of controlling fog bells on the south side of the Tyne Harbour from the North Pier Lighthouse at Tynemouth. This will be effected by means of a photoelectric transmitter in the North Pier light beaming an infra-red ray about 1,300-ft. across the harbour entrance to a receiver installed in the unmanned South Pier light. When the beam is turned off, it actuates a tumbler switch which sets fog bells sounding at the South Pier light and also at the Herd Groyne some distance away. It is believed that this will be the first instance in Britain of photoelectric equipment being used to control fog bells.

The Port of Walvis Bay

Completion of Extensive Development Works

(Specially Contributed)

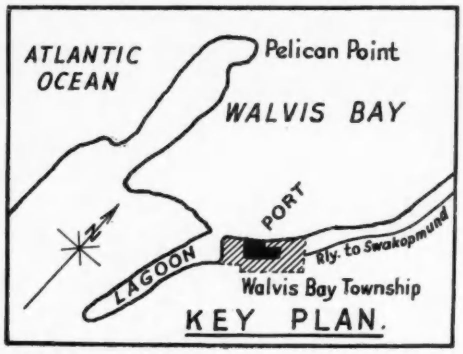
On the long stretch of South African coastline, from Saldanha Bay to the borders of Angola, there is only one major harbour, Walvis Bay. As this harbour was never a German possession—the port together with some of the hinterland was first a British possession and was then handed over to the old Cape Colonial Government—the German Administration tried to develop a port for German South West Africa at Swakopmund. The project was a failure and although there are a few minor harbours on the South West African Coast, the only one of any consequence is Walvis Bay which during recent years has been steadily improved and equipped by the South African Railway Administration.

Walvis Bay is the recognised ocean gateway to South West Africa but as a harbour it has few natural advantages. What it is to-day is the result of years of careful planning and of heavy expenditure. During 1960, 331 ships totalling 908,757 net registered tons called at the port and the volume of cargo handled totalled 861,546 tons, comprising 298,631 tons imports and 562,915 tons of exports. In addition 633 passengers were disembarked and 718 embarked.

Such activity has become the rule at Walvis Bay in recent years and consequently the harbour facilities provided in 1927 were found inadequate and have been unable to cope with the steadily increasing demand. Improvements to the harbour have therefore been undertaken in stages. The quay has been lengthened by 3,140-ft. at a cost of over R7-million (£3½-million), a new tanker berth has been built at a cost of R374,000 (£187,000), and extra cranes, including a 15-ton wharf crane, have been bought. An extensive dredging and reclamation programme is now in hand, and when the entire programme is completed, during the summer of 1962, the harbour will have eight berths, the separate tanker berth which was taken into service recently, and 23 cranes.

Storage accommodation is provided by 50,130 sq. ft. of raised level ore platforms and there is unlimited storage ground for rough goods. Privately owned storage facilities for bulk oil is available, consisting of 33 tanks with an aggregate capacity of 66,523 tons. The port also has two first-class tugs and one pilot tug all equipped with radar, wireless telegraph and telephone, direction finding apparatus and salvage and fire-fighting equipment.

Repair facilities at Walvis Bay consist of a slipway 685-ft. long and 40-ft. wide, with accommodation for three vessels at a time, side slips being provided to take one craft on each side of the main cradle.

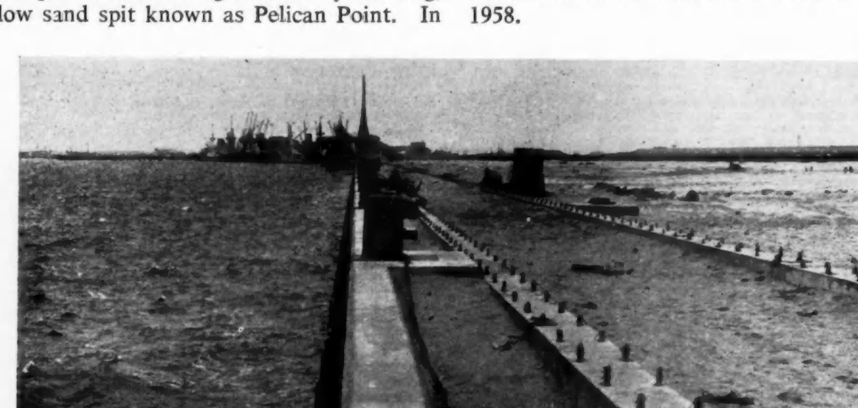


Quay Extension

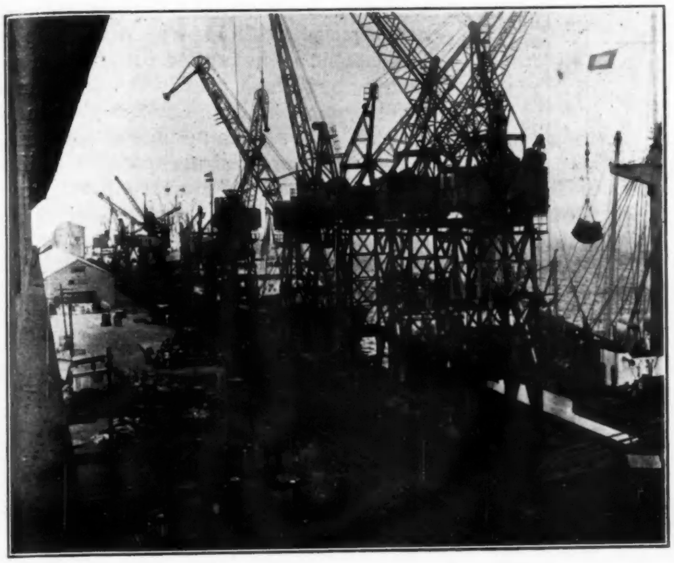
Unlike other Union harbours, the Port of Walvis Bay has no breakwater protection, adequate shelter being afforded by the long, low sand spit known as Pelican Point. In planning the layout of the new quay extension, due cognisance had to be taken of the heavy concentration of pilchard processing factories and fishing boat jetties located north-east of the existing harbour installations. The logical direction of expansion was in a south-westerly direction and a straight quay alignment was initially considered. However, a 17½ degree kink was ultimately introduced 100-ft. from the end of the existing quay house, because the existing travelling bulk ore loader, located on No. 3 berth, was a definite tie point, since wharf cranes could not be transferred beyond this installation to the new quay extension, and the need for generous land areas behind the quay to accommodate cargo sheds, stacking areas, marshalling yards and possible future bulk ore handling appliances, was of prime importance.

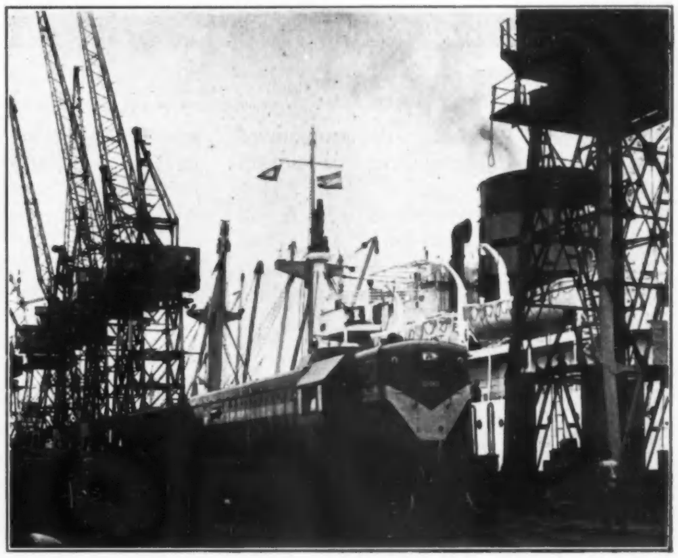
With this layout, the berthing of three large freighters was comparatively simple. Further, the decision to set aside No. 4 berth as the bulk ore berth would mean that any ore loader could be stationed at the kink when not in use, thereby allowing uninterrupted travel for all wharf cranes located on the new extension.

Late in 1957 the Administration called for tenders on a world-wide basis for the design and construction of a 1,400-ft. reinforced concrete quay extension which would make provision for two berths having a designed depth of −35-ft. L.W.O.S.T. Work was commenced on the site in May, 1958.



A view of the new 3,140-ft, extension of the quay, The reclamation (on right), the rubber fenders and the "kink" (at top), can be clearly seen.





(above) A quayside scene at Walvis Bay, and (right) A goods train being hauled from the quayside by one of the new diesel locomotives recently placed in service in South-West Africa.

An interesting feature of the design is the adoption of a heavy tubular rubber fender system as opposed to the normal floating fender or fender pile in use at Union harbours. Increasing use has been made of rubber for fender units in recent years and its adoption at Walvis Bay is in keeping with modern trends.

Later a second contract was awarded, this time for a further extension of the quay wall by 1,740-ft. which meant that in all five berths would be added.

The five new berths are to be equipped with seventeen 4-ton and one 15-ton electric wharf cranes of modern design, and a system of electric capstans and fairleads to assist truck movements on the quay. Three sets of railway tracks will be provided between the cranes and cargo sheds whilst a fourth portal track will be laid on berths 6 and 7 to cope with heavy lifts.

Due to the increased use of forklift trucks and palletised traffic, the two 400-ft. x 100-ft. cargo sheds to be erected at berths Nos. 5 and 6 will have no quayside platform. The sheds are to be positioned well back from the quay face to facilitate the movement of mechanical handling appliances and the floor of the sheds will be ramped at 1 in 60 to gain height for the rear rail side platform. The 100-ft. clear span of the sheds with liberal stacking height, aluminium tilting-type doors and generous areas of natural roof lighting should prove well suited to conditions at the port. Due regard has also been given to the important role played by road transport in any harbour undertaking and a broad access roadway located behind the cargo sheds and running the full length of the old and new quays is a feature of the layout.

The magnitude of the scheme under review has had important repercussions on the ancillary buildings, installations and services required for the efficient operation of any port. Provision was made for new administrative offices for harbour personnel, stores buildings, mechanical workshops, goods sheds and so on. Further, it has been accepted that the substantial quay extensions and harbour facilities will result in a corresponding increase in rail marshalling yard requirements. This need is to be met by the provision of new station buildings and a yard remodelling scheme on a new site, thereby making available the existing station facilities for harbour traffic.

A fork lift truck handling palletised cargo.

Tanker Berth

Tankers visiting Walvis Bay used to discharge their bulk oil cargoes at No. 1 berth, from where the oil was pumped to the oil installations situated approximately 1½ miles to the north-east of the harbour. In view of the hazard of bulk inflammable cargoes, it was decided to provide a new tanker berth at the base of the channel entrance—a considerable distance from the commercial berths.

Because of the economic advantages, the design of the oil berth follows the modern trend of providing dolphin-type structures for such berths. Tankers now berth against two breasting dolphins each 62-ft. x 32-ft. supported on sixty-two 16-in. x 14-in. reinforced concrete piles, raking in different directions with the exception of two verticals located at the back corners. Mooring dolphins on a smaller scale (32-ft. 6-in. x 18-ft.) are located on either side of the breasting dolphins whilst a hose handling platform (36-ft. x 29-ft.) is positioned centrally on the berth. The hose handling platform is not designed to withstand impact and has therefore been located behind the berthing line.

Two fender units are installed on each breasting dolphin, each unit comprising four large cylindrical rubber blocks faced by hardwood timber. The rubber blocks are recessed into the front face of the dolphins and were given a slight measure of precompression on installation.

The system of reinforced concrete dolphins and hose handling platform is connected by means of hardwood catwalks founded on timber piles, whilst a timber approach catwalk, approximately 1,100-ft. in length, provides the desired shore access for

(Continued at foot of following page)

Closely Spaced Piles as a Breakwater

Conclusions from Laboratory Tests

By R. L. WEIGEL

One possible solution to the problem of creating an area sheltered from wave action is the use of closely spaced piles. This possibility is usually considered when a pile supported pier is needed and it is desired to obtain double use from the structure. Theory and laboratory studies show that this is not a practical solution.

Consider a single row of piles of diameter D and distance betweeen piles b. As an approximation it can be assumed that the portion of the power transmitted past the pile structure is proportional to the gap portion of the pile structure:

$$P_T/P_I = b/(b+D)$$

where P_T is the power transmitted past the structure and P_I is the power transmitted by the incident waves. The wave height is proportional to the square root of the wave power, so

$$H_T/H_I = \sqrt{P_T/P_I} = \sqrt{b/(b+D)}$$

where H_T is the transmitted wave height and H_I is the incident wave height.

As an example, if a row of 14-in. diameter piles were placed with 10-in. between piles the transmitted wave height would be 63% of the incident wave height. If the same piles were placed with only 3-in. between them the transmitted wave height would be 42% of the incident wave height, and if the space were reduced to only 1½-in., the transmitted wave height would still be 31% of the incident wave height.

A 1 : 12 scale model study by the author showed the values of H_T/H_I of 0·83, 0·53, and 0·43, respectively for these pile arrangements. It is believed that diffraction effects are responsible for the fact that the measured transmitted wave heights were nearly 25% greater than the simple theory predicts. Tests made with the line of piles at a 45 degree angle with the waves showed this to be less effective as a breakwater than when the line of piles was normal to the direction of advance of the incident waves.

The phenomenon is more complicated when the pile array consists of more than one row of piles. The second row of piles transmits a portion of the wave power that gets through the first row of piles and reflects a portion of the power, the relative amounts depending upon the geometry of the array. The reflected portion is partially transmitted back through the first line of piles and partially reflected by it, but with a phase lag between this and the original wave. This wave is then partially transmitted through the second pile line and partially reflected again, with a phase shift from the original transmitted and reflected waves, etc. In addition, a portion of the energy is scattered, the scattered wave having a frequency that depends upon the pile diameter, and a portion of the energy is dissipated by skin and form drag.

Costello (1952) made a laboratory study of several arrays of piles, Fig. 1. The number of piles used in experimental set-up (b) is the same as in (a) and (c) although the number of rows of piles in the direction of wave advance is only one-half that in (a) and (c). For a given number of piles, there does not appear to be any appreciable difference in the effect of the various array configurations upon the effectiveness of the structures as a breakwater. It can be seen that the steeper the wave (the greater H /L, where L is the incident wave length) the lower is the transmitted wave height, all other factors being the same. It is evident that such an array is not effective as a breakwater.

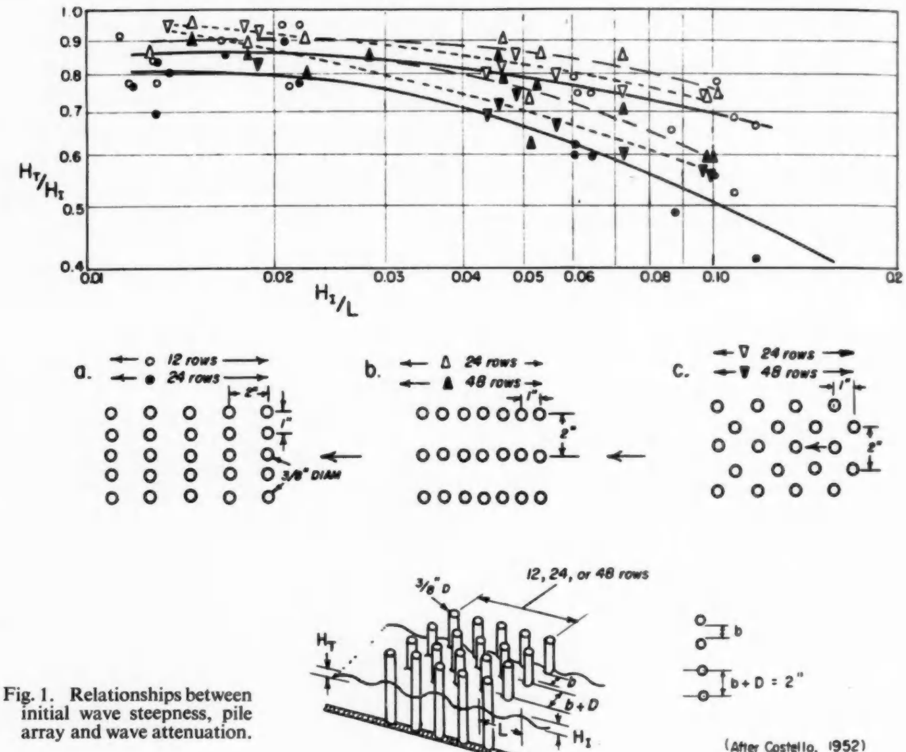


Fig. 1. Relationships between initial wave steepness, pile array and wave attenuation.

The use of a row of closely spaced piles appears to be illusionary as a relatively cheap breakwater, as is also the case for a vertical thin barrier extending from the bottom up to a short distance beneath the water surface (Wiegel, 1960). Furthermore, it is ineffective for the same reason—namely, that the wave height is proportional to the square root of the wave power. Thus, if a structure permitted only 4% of the wave power to be transmitted it would transmit a wave 20% as high as the incident wave.

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Walvis Bay—continued

pipes and personnel. Since marine borer attack in Walvis Bay is almost negligible, ordinary South African gum piles were used for this phase of the work. Provision has been made for one 12-in. and one 10-in. diameter oil pipelines, but should development warrant their installation the approach catwalk is capable of accommodating a further two 12-in. diameter lines.

Dredging and Reclamation Programme

The dredging and reclamation programme is closely linked with the two projects described above and embraces the deepening of the existing entrance channel and turning basin to −33-ft. L.W.O.S.T. together with the dredging of the tanker basin and the area opposite the new quay extension to a similar depth. Immediately adjacent to the new quay a strip dredged to −35-ft. L.W.O.S.T. and 100-ft. wide is being provided. The total quantity of dredging involved is nearly five million cu. yds.

Lighterage in London

By H. P. ROBOTTOM, M.Inst.T.*

Lighterage, or the carriage of cargo by one form of barge or another, has been going on in many rivers and harbours throughout the world all down the ages. I think the word "lighter" must literally refer to the type of vessel used in harbours or estuaries for the purpose of lightening an ocean vessel of its cargo. Anyhow, all my endeavours to find the origin of the word from dictionaries and the like lead me into confusion, so I ask you to accept my simple explanation of the derivation of the name "lighter." The vessel used to convey goods from a ship or quay to another more distant destination is, in my view, properly referred to as a barge; the Port of Hull uses these names correctly in the two senses—the lighter for local port work and the barge for its estuarial and upgoing (or "upgating" as it is called locally) river traffic vessel. London, on the other hand, refers to all its lighters as barges and to the men who operate them as lightermen. Barges, I find, are called many different names around the English coast and inland waterways, such as boats, lighters, flats, Tom Puddings, wherries, keels, trows.

Composition

In the Port of London there are registered 6,344 barges and 389 tugs; in Hull, 700 barges and 30 tugs; and in Liverpool, 235 barges and 50 tugs (9 for craft).

Although all the barges in London are used within the 40 miles of London's great port, of the 700 craft in Hull, 300 only are used within the port and 400 are upgoing barges trading to Leeds, Sheffield, Doncaster, Newark, Nottingham, York, Bradford, Goole and Gainsborough. Barges based on Liverpool trade to and from Manchester, and, at the other ports mentioned, solely within the port. A lot of the lighterage trade of the Port of Rochester is intermingled with that of London, there being quite a good deal of movement between the Thames and "that other river."

Also in London, to serve this fleet of barges there are 45 individually owned repair yards, and 3,000 lightermen licensed triennially by Act of Parliament by the Port of London Authority and registered as port labour by the National Dock Labour Board. About 40 of London's tug fleet are the ship attendance tugs you see lying at Woolwich and Gravesend, but the remaining 300 odd are used to move the port's barge fleet around.

There are, of course, the paint manufacturers, rope makers, tarpaulin works and ships' chandlers in addition, to serve this vast fleet.

Ownership

There are no fewer than 128 individuals or firms who are registered owners, and fleets within those ownerships can range from three barges to six hundred barges, with a proportionate number of tugs. Some companies own both barges and tugs, some barges only, and they look to towage contractors who own tugs only to perform their towage. There is also a diminishing section of the industry that owns barges solely for the purpose of letting them on hire to Master Lightermen.

This industry, like any other, has its peaks and depressions, and it is the desire of every Master Lighterman to make the optimum use of his lighters to cope with his surplus for just as long as it suits him; hence the usefulness of having the facility of hiring. In addition there is letting and hiring between Master Lightermen, which goes on in an amicable way throughout the year.

It is interesting to note that this is one of the remaining trades where the family connexion persists, and there are many registered owners today whose forebears go back generations in the trade.

A degree of amalgamation has occurred since the war, and it is safe to assume that this will continue for the obvious reasons that cause amalgamations to occur in so many other trades.

Types of Craft

The Thames swim-ended barge has been a familiar sight for many years. It was the shape of the wooden Thames barges in the days when they were propelled by sail, and many will also have seen them being rowed up the river by long oars or sweeps, although this practice is almost extinct and is used mainly today as a way of training apprentice lightermen on the run of the tides in the river and a general understanding of the feel of a barge when berthing alongside a wharf.

There are still a few 50-100 ton "punts" in work, but, generally speaking, 160 tons is the smallest barge normally used in the main river, and these range in carrying capacity up to 300 tons, but there are, in fact, some half-dozen or so of 500 tons capacity.

Barges loading ex-steamer in the docks, and requiring to travel up creeks and through locks, obviously are restricted in width and length. For example, a Regent's Canal size barge can carry 95 tons only as a maximum.

There are insulated barges for refrigerated meat and dairy produce, and tank craft for oils in bulk and petrol; both these latter are required, under the Port of London Authority bye-laws, to be surveyed annually by Lloyd's Register of Shipping. Many of the hatched barges are Customs Approved and are liable to inspection from time to time.

Photo Courtesy J. W. Cook & Co. Ltd.

Launch tug "Squally" and Lighters.

Towage

The movement of London's large fleet of barges by tugs is greatly assisted by a 3-knot ebb and flow of the River Thames, which is normally reliable in its consistency and comparative tranquillity, without abnormal bores or other variations experienced in so many rivers.

Of the 300 odd tugs used in the towage of barges, the majority is designed and constructed to tow the maximum permissive tow of six barges with the help of the tide. Therefore, it is natural that the work proceeds on the river according to the ebb and flow, highwater time at London Bridge being the focal point of the working day of a lighterage manager. For example, if highwater is at twelve noon, it is necessary for the person responsible for planning the tug's work to calculate that it will take 2½ hours with a full tow to reach London Bridge from the time it leaves Tilbury. Due allowance has also to be made for any delay in undocking at Tilbury, and ahead of all that, has to be calculated at what time the lightermen must be ordered to travel from London to reach Tilbury in time to undock and be ready to be towed away.

*Paper read before the Metropolitan Section of the Institute of Transport, March 1961. The author is Manager and Director, James W. Cook and Co. Ltd.

Many of these tugs would be quite incapable of towing their tow against the tide, and some are hardly able to stem the tide. There has been, however, in recent years a tendency to build more powerful tugs so that to some extent the tide can be ignored.

The general appearance of barge-towing tugs will be familiar; suffice to say that the engines of the powerful tugs just referred to are in the region of 500-700 b.h.p., the average tug about 300 b.h.p. and the small launch type tugs 100-120 b.h.p. These latter serve a good purpose in internal dock towage and in travelling up the various creeks to their destination early on the flood tide.

Both of the larger size tugs are manned by four or five men in the crew, the smaller tugs having two only, the captain performing the navigation and engine controls.

There remain a few steam tugs, but it has been recognised for 30 years that, for economic reasons, the running costs incurred by bunkering time, steam raising and the banking of fires at the end of a watch, give motor driven tugs a great advantage. For example, over a given period with similar powered tugs, coal bunkers will cost £423 and diesel oil £163.

The study of propeller efficiency, arguments for and against high-speed engines, direct reversible engines against clutch and gear box controlled types have gone on and will go on for many years. In my view it is necessary to keep the design of the engine room to the most simple type, where semi-skilled engineers can operate without the confusion which could occur with elaborate equipment, auxiliaries, etc. In the matter of design, even power operated steering can incur high maintenance costs in the lifetime of a tug, and there are many tugs on the river today that retain hand-power only. The design and engining of tugs is a study in itself, and perhaps the few facts given so far will convey some idea of what goes on in the tug that one sees going under Tower Bridge.

Insurance and Registration

It might be wondered whether the entry into the lighterage industry as a tug and barge owner is free for all. In a way it is, but it is not easy without a good deal of specific knowledge. Apart from the initial capital, in order to be efficient a good deal of knowledge is required of all the background restrictions and obligations. For example, one would require to know, to start

Photo Courtesy P.L.A.

A tow leaving the King George V Entrance Lock.

with, under what terms and conditions lighterage is undertaken. This is summed up simply by reference to the famous London Lighterage clause; but what trials, tribulations and test cases have gone on in the past before this apparently simple clause became accepted as an Institute clause, and understood and accepted by most people. The disclaiming by Master Lightermen of any responsibility whatsoever other than for a limited amount of loss by pilferage is not so severe as it seems and the reason for it is simple. It is because greater acceptance of liability would mean high insurance premiums and consequent higher rates, and Master Lightermen have always sought to give the

Photo Courtesy P.L.A.

Barges being loaded with timber at the Royal Victoria Dock.

most economic service possible, recognising, as they do, that the tugs and barges they operate are the hand-maidens of the port.

Behind the conditions of carriage there are obviously certain insurances required for the owners of the tugs and barges. Naturally there are specific requirements for mechanical failures, explosions of boilers and air receivers, fire risks to the barge, even though caused by its cargo, and such limited claims as might be legally brought against the lightermen in spite of the London Lighterage clause. On the whole, although important, insurance does not entail a big share of operating costs, as it does in certain industries.

One of the safeguards to tug and barge owners is the fact that their craft have the benefit of the "limit of liability" under the Merchant Shipping Act, and although two years ago there were adjustments made to certain values, this is, nevertheless, a safeguard and is assured to craft owners by reason of their registry with the Port of London Authority.

The Port of London is the only port where the controlling body is permitted by Act of Parliament to function as a Registration Authority. In other ports such as Hull, barges requiring this safeguard have to be registered with the Ministry of Transport.

The operation of registration is comparatively simple, and the Port of London Authority's officer is readily available to measure and inspect the barge and assess its registered tonnage. A certificate is issued and annual fees are paid of 9d. per ton.

Dock Dues

Other than the annual fee for registration mentioned above, there are no obligatory charges in the use of the river and its water, except for dock dues and then only under special conditions.

The use of the whole of the river, wherever it is tidal, its main run, creeks and tributaries, is free, so also is entry into and exit from its docks so long as a barge enters bona fide to collect or deliver its cargo from or to a ship or shed, and does not become guilty of harbouring. A barge becomes liable for dues if it enters a dock more than two tides before the arrival of its ship, or if it does not leave within two tides after completion of loading. What at first sight seems a small amount can rise considerably, as the

following figures show: For a barge of 100 tons register (equalling 170 tons capacity) £4 15s. 8d. is charged for the first week or part of a week, and thereafter 7s. 2d. per day.

The right of the Free Water clause has been fought for strenuously by river craft owners over the years, and the fight would be continued if it became necessary. The recent history in the Port of Hull exemplifies this, and I for one am glad to know that the British Transport Commission has dropped its claim to charge dues at that port other than as in London.

The only variation to this freedom of movement is concerning obvious hazardous cargoes, such as petroleum spirit, calcium carbide, etc. Barges intended for the carriage of these goods are required to have an annual licence from the Port of London Authority, who readily issue the certificates so long as the owner of the barge produces a certificate of port worthiness from an approved body—in the case of London, Lloyd's Register.

Lighterage Rates

Contrary to what is commonly supposed, there is no recognised schedule of rates within the port. Lighterage contractors are free to charge what they wish, and in fact, do so. The charges are generally split up under the following headings: a tonnage rate for lighterage, a minimum, a shifting charge, demurrage.

It must be understood, that, to those working on it, the river and its docks are a very narrow street and all concerned in the lighterage industry are well aware of the work of their competitors' clients. Any cut-throat competitive rates, which could attract business from one contractor to another, cause obvious disturbance and retaliation, particularly where it is borne in mind that in general terms there is only a limited cake to be shared on the river.

Throughout any year there are peaks and depressions, coupled with which is the unfortunate fact that in the last ten years the tonnage handled by the industry in the Port of London has been dropping. This has been due to changes in operating methods by big manufacturers, changes in the terminal markets of the world and loss of transhipment cargoes. Increasing operating costs have forced up lighterage rates so that they are no longer competitive with road haulage; towing expenses and labour conditions and rates of pay have become more onerous, so that, for example, a pre-war minimum of £4-£7 has now become £25-£32, thus precluding a good deal of small parcel traffic from the river. A 160-ton barge which, before the war cost £10 per ton, now costs £40 per ton. A 400 brake horse power tug, which used to cost £17,500, now costs £50,000. Repairs and maintenance have increased even more. However, it is to be hoped that, although the pattern of trade is changing, there will be a continuing requirement for a tremendous annual tonnage of lighterage, and in some respects the lighterage requirement may increase. There is no one set of statistical figures available to give a true picture of the total amount of lighterage undertaken in the port in a year, but it is safe to assume that it is in the region of 15-17 million tons.

The results of this year's heavy arrivals in the port, together with a heavy rainfall, have shown that there are far too many barges in the port. Their high value and consequent high rates make it uneconomic to use them as warehouses, as in the old days, to help spread the load during peak arrival periods. I am thinking particularly of this season's timber, when, because the London facilities both in the docks and private wharves have not been increased greatly since the war, 200-300 extra barges could have been used had they been available, but, of course, only for a limited period in the year.

Better use must be made of existing barges and constant attention is being given to the speedier turn-round of available craft.

A word or two about the unfortunate word "demurrage." The need to charge demurrage is very clear, as I hope the following sum shows.

A Master Lighterman knows his likely costs to carry, say, 150 tons of bulk wheat from alongside a ship in Victoria Dock to a mill on the riverside. He allows in his reckonings two days to load and two days to discharge, and one day for the movement of the barge—five days in all. He quotes his rate on this assumption, and thereby reckons to earn a total of £62 10s. or £12 10s. per day for the duration of the voyage. Once the five days have expired, unless there is a proper demurrage charge, the daily earnings reduce, and it will be seen by the figures below how a profitable operation gradually becomes unprofitable after the first five days even with demurrage at £3 12s. per day:—

	Total revenue	Average revenue per day
Freight rate for five-day voyage ...	£62 10s.	£12 10s. 0d.
6th day (with demurrage) ...	£66 2s.	£11 0s. 4d.
7th day ,, ,, ...	£69 14s.	£9 19s. 2d.
8th day ,, ,, ...	£73 6s.	£9 3s. 3d.
9th day ,, ,, ...	£76 18s.	£8 10s. 11d.
10th day ,, ,, ...	£80 10s.	£8 1s. 0d.

Conclusion

It is often stated by those outside the industry that it should be nationalised or amalgamated, or, at any rate, brought under one control. We have, however, had a national experience, which has proved that it is not necessarily a wise course. I think, as I have said earlier, that some further amalgamations will take place, but the industry, in my opinion, is too large to have under one type of control. Perhaps a degree of rationalisation could occur to help reduce costs, such as standard types of barges, collective purchase of equipment and consumable stores, and the streamlining of repairs. A good deal of thought is being given to these aspects, however, and no doubt the normal evolutionary process will bring its changes and improvements.

Diesel Shunting Locomotives for Southampton Docks

The 18 steam shunting engines now employed at Southampton Docks are to be replaced by 14 diesel-electric locomotives, each of 275 h.p. These are to be supplied by Messrs. Ruston & Hornsby of Lincoln, and delivery is expected to be completed by the autumn of 1962.

With nearly 80 miles of railway track within the Docks, shunting engines play an important part in day to day operations. They were first introduced in 1872 when six four-coupled tank engines were purchased by the Southampton Dock Company. When the Docks were acquired by the London and South Western Railway Company in 1892 the locomotives then in use were replaced by those of the B4 Class, which, although large for their day, had a short wheel-base, and 14 of them were allocated to the Docks. These B4 locomotives remained in service until after the last war when they were replaced mainly by ex-United States Army Transportation Corps six-coupled engines which had become available for purchase. These have proved very suitable for Dock working but are now uneconomic.

The diesels will be fitted with radio-telephone sets which have been standard equipment on Southampton Docks shunting locomotives for the last four years. These allow two-way conversation between the Control Offices and engine crews, so that instructions can be passed to locomotives on any part of the Dock Estate. A fuelling point with storage capacity for 5,000 gallons of diesel oil is to be installed in the Old Docks.

In order to provide the steam heating required for the passenger coaches making up Boat Trains, boiler vans are being constructed with oil-fired boilers capable of raising steam in four minutes.

Progress in the Development of the Hovercraft

Specially Contributed

At a time when there is intense competition between sea and air services for handling passengers and cargoes, it is interesting to note the developments which are now taking place on the comparatively new transport concept of the hovercraft.

It will be recalled that the hovercraft was first introduced in 1959 and was the invention of a British electronics engineer, Mr. C. S. Cockerell. After experiments had been carried out to determine its feasibility, his proposal was taken up by the National Research Development Corporation which through a subsidiary company, Hovercraft Development Ltd., placed a contract with Saunders-Roe of Cowes to design and develop the first prototype model. Six years later, in June, 1959, a small experimental hovercraft, the SRN-1, weighing 4 tons and with an oval base measuring 30-ft. by 24-ft., made its first flight over water, skimming the Solent at a height of 1-ft. and at a speed of 25 knots. A month later it crossed the English Channel from Calais to Dover in two hours at an average speed of 13 knots. The National Research Development Corporation thereupon instructed Saunders-Roe to prepare designs for an experimental hovercraft capable of being employed as a cross-channel ferry with accommodation for 80 passengers or, alternatively, space for 40 motor cars.

Since then considerable progress has been made in solving the various engineering problems connected with this form of transport and other firms have announced their interest in its development. While Saunders-Roe are building the SRN-2 which, when completed, will weigh 25 tons and be capable of carrying up to 68 passengers or 10 tons of cargo and will have a cruising speed of 70 knots, Vickers-Armstrongs and the Hawker Siddeley group are in the process of designing and constructing several sizes of hovercraft.

The basic design of these vehicles comprises a primary structure in the form of a stiff platform, taking the distributed pressure of the air cushion on the bottom surface. Fans lift engines and distribution ducts for the peripheral jet are mounted on this platform, with the remaining area providing accommodation for passenger cabins and/or cargo holds. Controls are provided to stabilise the craft in heave, pitch and roll, and to counteract the effects of side loads and yawing movements. Model tests have been made over water, ground and in wind tunnels, to determine the aerodynamic behaviour and ground interference effects. To follow up these tests a research hovercraft VA-1 was built.

The design principles outlined above were incorporated in the research vehicle, which was fitted with bare essentials only for the first overland tests. In this condition it became operational in 1960 at a weight of 3,300-lb. and a hoverheight of 4·5-in. It has been operated continuously since that time with various modifications including several different lift curtain systems. Stability devices, such as dividing the cushion into compartments and associated controls have also been developed. Various fairings and a cabin have now been added as protection for over water trials. These modifications have increased the weight to 3,500-lb. and the hover-height to 4·1-in.

It is recognised, at this state in its development, that practical demonstration, particularly overseas, is essential with such a new type of transport and therefore a vehicle has been constructed which is small enough to be airfreighted to demonstration sites and yet sufficiently developed to proye the engineering design and the practicability of application. This small craft, designated VA-2, is a utility vehicle, carrying four or five people, with a speed of 40 knots and an endurance of 1½ hours. In addition to its use for demonstrations and route assessments for prospective operators, the craft has immediate applications as a fast executive transport over sheltered and inland waters and for the transport of personnel and equipment over difficult terrain where existing types of vehicles cannot operate.

The vehicle is powered by three light aircraft piston engines, two for lift and one for propulsion, and the hoverheight over a solid surface is 8·5-in. It is 28-ft. 4-in. in length, 14-ft. 10-in. in breadth and has a height of 10-ft. 4-in.

A further craft VA-3 is already under construction and will be 10 tons in weight. In the role of fast passenger ferry, it will operate in river estuaries and similar terrain where its amphibious capabilities will allow it to travel over water with waves up to 2-ft. and over shoals and mudbanks. The cabin is fitted to accommodate 24 passengers and crew. For survey the craft can be fitted with a cargo area and could then carry some 4,000-lb. of equipment plus crew for a distance of 80 nautical miles at high speed.

Four Blackburn Turmo-turbine engines are used for the lift fans and propulsion drives, but the design is sufficiently flexible to permit the use of alternative power units. For the propulsion system two reversible, variable pitch, 4-bladed propellers are used. The pitch change provides reverse thrust which is used for braking and to aid manoeuvrability. In addition to the directional control provided by the propulsion system, cable operated control surfaces on the port and starboard coamings provide effective "keel" area to prevent drift and to assist in turning.

The overall dimensions of the assembled craft are: length 52-ft. 6-in.; breadth 25-ft. and height 17-ft. 9-in.

A great deal of advanced planning has been carried out by Vickers-Armstrongs at South Marston on deep-sea going hovercraft. For the type of seas likely to be encountered on unprotected waters 100 to 1,000 ton hovercraft have to be considered. These large sizes are dictated by two factors. First, for open water operation all through the year, the wave conditions require larger craft with greater hoverheight to keep the structural loads and power requirements to reasonable values. The second factor, which derives from the relationship of cushion area to perimeter, leads to improved economy of operation, in terms of ton miles per horse power installed. This is due to the relative saving in power and the greater disposable load in the larger craft. Thus the larger ranges required for open sea journeys become economic in terms of fuel to payload ratio.

For operation closer to the surface, both overland and over waves, the development of flexible structures is receiving attention. The structure of a hovercraft is largely dictated by the impact loads. In the first designs, adequate clearance was provided by having higher powered lift systems, since the structural penalties in designing for greater impact are prohibitive. By introducing flexible skirts the major design limitations are overcome. Local impacts and abrasion is not borne by the main structures, but by the flexible components. These can be designed to accept high accelerations, and thus the accelerations and loads transferred to the main structure can be greatly reduced. However, these developments are still in their early stages in terms of engineering. Although flexibility in its simplest form is already being tried in the form of rubber sidewalls or skirts, the ultimate servo-actuated mechanical device may take 10 years to perfect.

Meanwhile, an early scheme for a craft of around 100 tons, type VA-4 has been drawn up. This craft with a hoverheight of up to 3-ft. and capable of speeds of between 70 and 80 knots, would have a length of 173-ft., a beam of 58-ft., an equipped weight of 61 tons, with fuel and payload accounting for another 49 tons.

Marine "Sidewall" Hovercraft.

Considerable interest has been shown in the experimental hovercraft designed and built by William Denny and Brothers Ltd. in collaboration with Hovercraft Development Ltd. and which carried out trials on Gareloch, near Dumbarton, last June.

This experimental "sidewall" hovercraft, weighing 4½ tons, is approximately 60-ft. in length by 10-ft. in beam and is rectangular in shape. It differs from other British hovercraft types in that the rectangular cushion is sealed along its sides which remain continuously in water and the machine never becomes fully airborne although its weight is supported by the air cushion. The front and rear of the cushion is sealed by an advanced air cushion system. The main advantage is that less power is required to maintain the air cushion and a more simplified jet system can be employed.

The air for the cushion and jets is drawn into the interior of the craft and forced by fans through ducted systems to each of the jet orifices. Forward propulsion of the machine is provided by two "Mercury" 300 outboard motors with variable pitch propellers, each developing 35 b.h.p. while power for the fans is provided by two 3-cylinder 2-stroke Excelsior engines each developing 25 b.h.p.

'Sidewall' hovercraft during recent trials on the Gareloch.

This hovercraft, built of plywood and sheet steel, is fully instrumented as a floating laboratory and will be manned by a crew of three—a pilot and two instrument observers. The Denny development programme is aimed at producing craft for operation in rivers and estuaries where a speed of 35 knots is considered the optimum maximum for safe navigation. High speeds are therefore not a primary requirement and the maximum speed of the research vehicle is in the region of 15-17 knots. Speed trials will be carried out at various hover heights in order to study the various drag components of the craft and its efficiency compared with orthodox vessels.

In confined waters such as rivers and estuaries which may be shallow, narrow and have fast flowing currents, conventional craft experience large penalties in wave drag and skin friction. Under such conditions a sidewall hovercraft should be able to operate efficiently without creating a wake which would either upset small craft or damage the banks of rivers and canals. In addition, this type of hovercraft offers particularly good steering and handling characteristics.

The Future of Hovercraft Services.

It has been recently pointed out that although the engineering problems associated with this form of transport are being solved, it is essential that what may be termed 'political developments' should keep pace. The transport licensing departments and port authorities must agree on requirements which will ensure the safety of passengers and crew and regulate traffic between various users of waterways, without penalising the new capabilities of this class of vehicle. The "man with a warning flag" type of restriction which has accompanied the introduction of new forms of transport in the past must be avoided. Air traffic and the growing volume of motorists already have forced more realistic customs procedures in international travel. To realise the potential of hovercraft transport, these precedents must be followed. If freed from such artificial restrictions, the new craft could have a considerable impact in the next ten years in the sphere of international transport.

Proof of the growing interest in the potentialities of the hovercraft was given recently when the U.S. Maritime Commission announced in Washington that it is negotiating with American companies to design an ocean going hovercraft. It described the vessel as a "surface-effect" craft operating by air pressure over both water and land and capable of climbing a ramp or beach where it could be unloaded. The Commission envisages a ship that could move over open ocean areas at high speeds and could meet commercial conditions.

The Hydrofoil Vessel

One alternative to the use of the hovercraft for future cross-channel services is the hydrofoil craft and considerable research is being undertaken by Aquavion Holland N.V. of the Hague, among others, on a large hydrofoil capable of carrying some 400 passengers at high speeds.

Its building costs are of course somewhat higher than the price of conventional vessels of the same size due to the special lightweight construction necessary to achieve sufficient rigidity and the construction of the foils which have to be made to close tolerances.

Above a certain speed the hull of a hydrofoil craft is lifted completely out of the water by a main hydrofoil situated slightly aft of the centre of gravity and two bow foils located on both sides of the stem and as far forward as possible. The main hydrofoil carries 85-90 per cent of the total weight of the aquavion and is always partially submerged. Its lift force results from a circulation flow around the foil and it has a special profile to obtain optimum efficiency.

Normally the bow foils support only 10-15 per cent of the weight of the craft and only their aftermost parts are planing on the water surface. However when they are pressed deeper in the water, they act in the first instance as planing surfaces over their total area and start functioning as normal hydrofoils when fully submerged. In this condition they produce a lift force approximately 50 per cent greater than the total weight of the craft. The bow foils together with the speed determine the position of the aquavion in relation to the water surface.

As soon as an aquavion attains a speed of some 25 per cent of the maximum speed the bow foils rise to the water surface; the hull then leans backwards and is still for the greater part carried by the water. With increasing speed the main hydrofoil lifts the hull gradually out of the water, until at about one half of the top speed the craft is wholly foil-borne. The hull has then been completely lifted out of the water but is still leaning slightly backwards. At the maximum speed the craft is carried horizontally above the water surface by the foil system. Thus, when the speed varies between 25 per cent and 100 per cent of the maximum speed, the aquavion pivots about the points of contact of the bow foils with the water surface in such a way that at low speed she leans slightly more backwards than at higher speeds.

The stabiliser does not carry part of the weight of the aquavion, but functions as a damper only and because it has zero incidence, it does not normally produce any lift force. However, a positive lift is developed during downward, and a negative lift during upward, motions of the stern of the craft. These lift forces counteract the corresponding motions so that the aquavion is prevented from oscillating in her natural frequencies, and so her dynamic stability is guaranteed on every possible wave-pattern, at all speeds and in any direction relative to the waves.

Wave Recording for Civil Engineers

Proceedings of a Conference held at the National Institute of Oceanography

The Measurement of Sea Waves

The study of sea waves is a science which has developed rapidly since wave forecasts were needed during the last war for the Allied landings on enemy beaches. Developments in electronics have helped to make it possible to record waves with a fair degree of accuracy, and many practical uses have been made of the records. Throughout the world, engineers who design coastal structures and ships have been taking increasing advantage of these available techniques.

In January this year a conference, organised jointly by the National Institute of Oceanography and the Hydraulics Research Station, was held to discuss the recording of waves from the viewpoint of the civil engineer. Four papers were presented by scientists engaged in research on waves or hydraulics; these were followed by informal contributions from engineers whose work involves them in structures associated with sea waves, and by a discussion. The texts of the four papers at this conference will be published in this and the succeeding two issues of The Dock and Harbour Authority.

The Information Required by the Civil Engineer

by R. C. H. Russell. M.A., A.M.I.C.E., A.M.I.Mech.E.
(Hydraulics Research Station)

It is regrettable, particularly from the point of view of a designer of wave-recorders who is keen to make his instruments increasingly precise, that civil engineers are seldom interested in the truth about ocean waves: they are even more rarely interested in the whole truth. The truth is complicated whereas civil engineers are equipped, generally speaking, to deal with relatively simple information.

Their plea is for a characteristic wave-height, wave period and direction of wave approach that can be fed into calculations. The calculations that are made on such matters as the forces on a group of piles, the wave-heights behind a breakwater, and the movements of a moored ship all require values of the three parameters height, period and direction. Civil Engineers are not equipped to deal with a spectrum of waves travelling not in a single direction but in a spectrum of directions. They require any record, which correctly shows the sea to contain a spectrum of waves, to be so interpreted as to reveal one wave-height, one period and one direction. The one wave that is obtained from a study of a record might be the average wave, the significant wave, the maximum found on the record or the maximum obtained by extrapolation from the record.

Which of these waves is used will depend upon the experiments or the calculations that are to be performed. Examples would be given below of cases in which the significant wave was used and likewise the absolute maximum wave and the limited-duration maximum wave, and one case would be given in which the full spectrum had to be used.

Significant Waves.

Structures which fail owing to being subjected to high waves lasting for a long time are commonly tested in models in the face of waves representing significant waves in nature. In this category are rubble-mound breakwaters and concrete structures that can fail if their foundations are scoured away by wave action.

There is so far as is known no experimental evidence that the damage done to a rubble-mound breakwater by a sea having a certain spectrum of wave-periods and heights is the same as the damage done by waves of the same significant height and period operating for the same time; yet this is the assumption made in the majority of the world's hydraulic laboratories.

In many cases the assumption is implicit in the method used to design the breakwaters: i.e. wave forecasting curves are used to predict the significant waves to be expected under certain meteorological conditions, and then the armour is chosen from laboratory data, which was obtained by subjecting breakwaters to uniform waves.

Absolute Maximum Waves.

There are other types of structure which fail clearly and irreparably when waves exceed a certain size; and for designing these one needs to know either the highest wave that can possible arrive or if there is no absolute limit, one needs to know how big are the biggest waves to be expected during a period of time several times as long as the life-span of the structure. By designing the structure to resist these unlikely big waves one ensures that there is only a slim chance of the structure failing during its intended life.

Structures for which the design wave must be the maximum wave include monolithic breakwaters and similar structures which fail by overturning.

A dam protected against wave action by precast blocks and tested at the Hydraulics Research Station was recently found also to be in this category. The precast blocks constituted the only line of defence against wave attack: beneath them lay only a filter of free-draining gravel. Experiments showed, as might be expected, that the blocks were stable in the face of waves up to a certain size; but that greater waves than this would pluck them off the face of the dam. The failure of the remainder of the armour followed rapidly the removal of the first block even if subsequent waves were very much smaller and it was therefore necessary to predict the size of the biggest single isolated wave likely to strike the dam during its anticipated life. There was no possibility of obtaining wave records because the lake was at the moment non-existent: instead waves were forecast based upon the assumption that future winds will be similar to past winds.

In cases like these the first waves obtained are significant waves. A coefficient is then sought by which to multiply the significant wave-height in order to obtain the most likely biggest wave to arrive in the intended life-span of the dam. For example let us assume that:—

The design storm involved winds of 60 m.p.h.
The storm would last for half an hour.
There would be 30 such storms in the life of the dam.
Accordingly there would be about 10,000 waves in all.
Using Longuet-Higgins' [1] paper on the statistical distribution of wave-heights to obtain the fact that

$$\frac{\mu(a_{max})}{\hat{a}} \text{ or}$$

$$\frac{\text{the probable value of the max wave amplitude}}{\text{root mean square wave amplitude}} = 3.014$$

for the sample of 10,000 waves, and that

$$\frac{a_{1/3}}{\hat{a}} \text{ or }$$

$$\frac{\text{the mean of the 1/3 biggest wave amplitudes}}{\text{root mean square wave amplitude}} = 1.416$$

The ratio $\frac{\text{max wave height}}{\text{significant wave height}}$ was taken to be $\frac{3.044}{1.416}$ or 2.15 and accordingly the design wave is found. This wave is the one, such that there is an even chance of the maximum wave-height exceeding it; and one might say that a structure designed to be critically stable in the face of this wave would be just 50 per cent safe. This is obviously an undesirable state of affairs which cannot be radically altered by merely extending the assumed duration to be several times greater than the life of the dam. At the time of speaking it is planned to change over to rip-rap as the armour on this particular dam, because its failure is brought about only by high waves persisting for a long time.

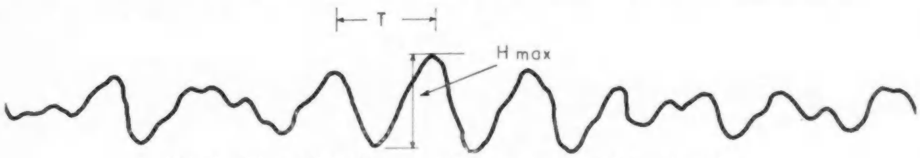


Fig. 1. Record exhibiting a clear maximum height and period.

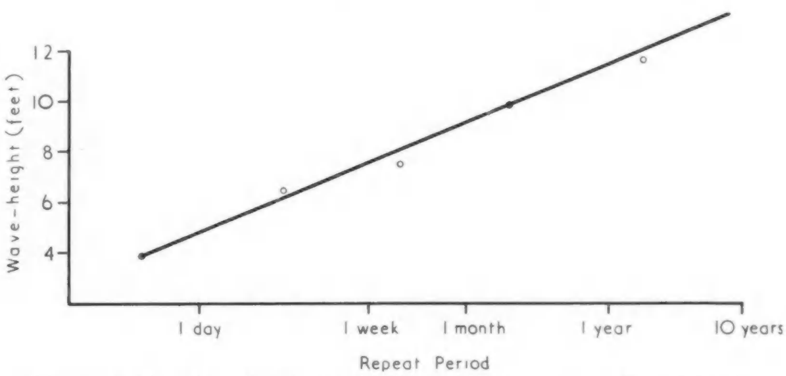


Fig. 2. A linear-log plot of wave height against average period of recurrence.

Limited-duration Maximum Waves

In connection with the very common type of investigation, where one is trying to ensure that waves inside a proposed harbour are sufficiently reduced to enable ships to lie quietly at their moorings, one should use a wave somewhat intermediate in height between the significant and the absolute maximum; the maximum on a fifteen minute record, for example.

Some half-dozen wave-disturbance investigations have been carried out by the Hydraulics Research Station and in not one of these were good wave records obtained. Sometimes it was not possible to install a recorder at all: sometimes the recorder worked only intermittently: sometimes the recorder worked well until there was a storm, when it failed: most recently the submarine cable of a recorder got out of place and was mauled by a dredger: on one occasion the recorder was installed after the model investigation was completed. However the few records that we have obtained recently are being analysed as follows:—

A fifteen minute record is examined in order to obtain from it the maximum wave-height measured either from trough to adjacent crest or crest to adjacent trough—it does not matter which, provided consistency is observed. The period of the biggest wave is also required and would be measured straight off the record, if it was a reliable measurement. We make the measurement more reliable by taking the average of the period of the five highest waves; making meanwhile the tacit assumption that there is no correlation between the heights of individual big waves and their periods.

The writer does not usually employ the significant wave period because its value is somewhat affected by small waves that have no effect on the movement of ships. Wave records tend to look rather like the one in Fig. 1, that is to say they contain mostly confused waves, but contain here and there a few markedly bigger waves of fairly obvious period almost free of superimposed noise. It is these waves that are likely to cause the fracture of mooring ropes and damage to ships plating, and these that we try to measure.

The information, plotted as a curve of exceedances on linear-log paper, commonly produces a straight line as shown in Fig. 2. In this form it is suitable for assessing the adequacy of the harbour. Quantitatively the harbour can be assessed by the number of days in the year, or by the number of two hour periods in the year, that the harbour is unworkable and this number can be obtained, after a model study, by examining how often waves of a certain height occur at sea during a year.

The problem is complicated by the fact that the protection afforded by the harbour, measured either as the ratio

$$\frac{\text{wave height at quay}}{\text{wave height at sea}} \text{ or as the ratio } \frac{\text{horizontal movement of a ship}}{\text{wave height at sea}}$$

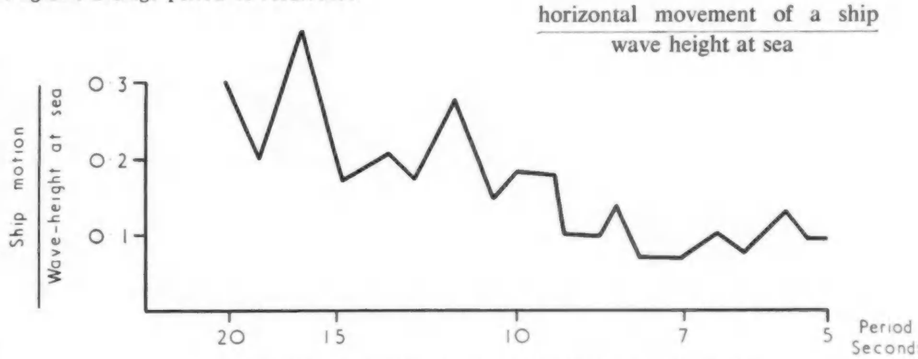


Fig. 3a. Response curve for an unrestrained ship at a berth.

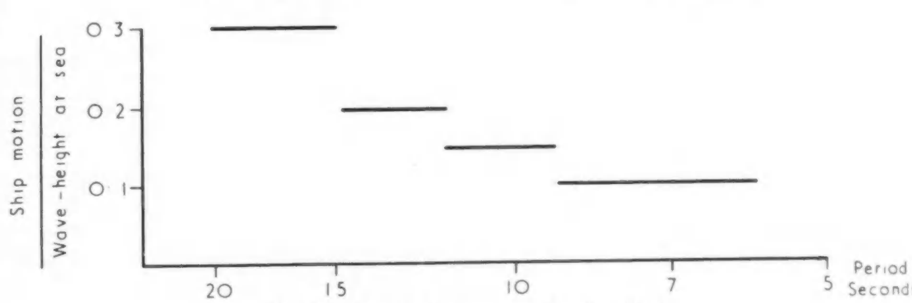


Fig. 3b. Response curve grossly simplified.

depends among other things on the period of the waves.

A typical response curve obtained in a harbour model is shown in Fig. 3a, which can be simplified somewhat grossly by averaging response over 3 or 4 wave period bands as shown in Fig. 3b. The wave data has then to be plotted as described above but broken down into these same wave period bands. There is an exceedancy curve for wave-heights for periods above 15 seconds, one for periods between 15 and 12 seconds, one for periods between 12 and 9 seconds and one for periods below 9 seconds, as shown in Fig. 4.

Finally the client is usually asked to specify the maximum vessel horizontal movement allowable, and the number of times in a year that the ship will move excessively, can thus be computed.

Therefore, considering the year to be divided into periods of 2 hours each, there will be excessive movement of the ship during 23 of these periods during one year.

Some harbours, in fact the majority of harbours, provide better protection from waves coming from one direction than from another. To assess the number of times such a harbour will become unworkable one needs to break down the wave data yet again into waves coming from various directions. One would then have sets of diagrams similar to the set in Fig. 4, one set for each direction of approach. This procedure is possible only if the wave data is obtained by hindcasting, whereby wave directions can be obtained, or if recorded wave data is backed up by visual observations of wave directions. Records of wave directions are obviously desirable.

is evidence that it is necessary to reproduce the full spectrum of waves. One of these problems is in the design of an embankment high enough to prevent overtopping by waves, research into which has recently shown that it is not possible to specify a wave, $H_{1/3}$ or $H_{1/10}$ for example, which has the same overtopping capabilities : one must simply reproduce the full spectrum in a model, generating the waves by wind.

Because the full spectrum is required, the wave should be measured by some device that records the short superimposed ripples as well as the major waves,—a resistance wire or capacitance wire probe for example. A bottom-pressure record is not acceptable.

Characteristics of the Recorder

The engineer prefers the record to include only the band of waves that are likely to

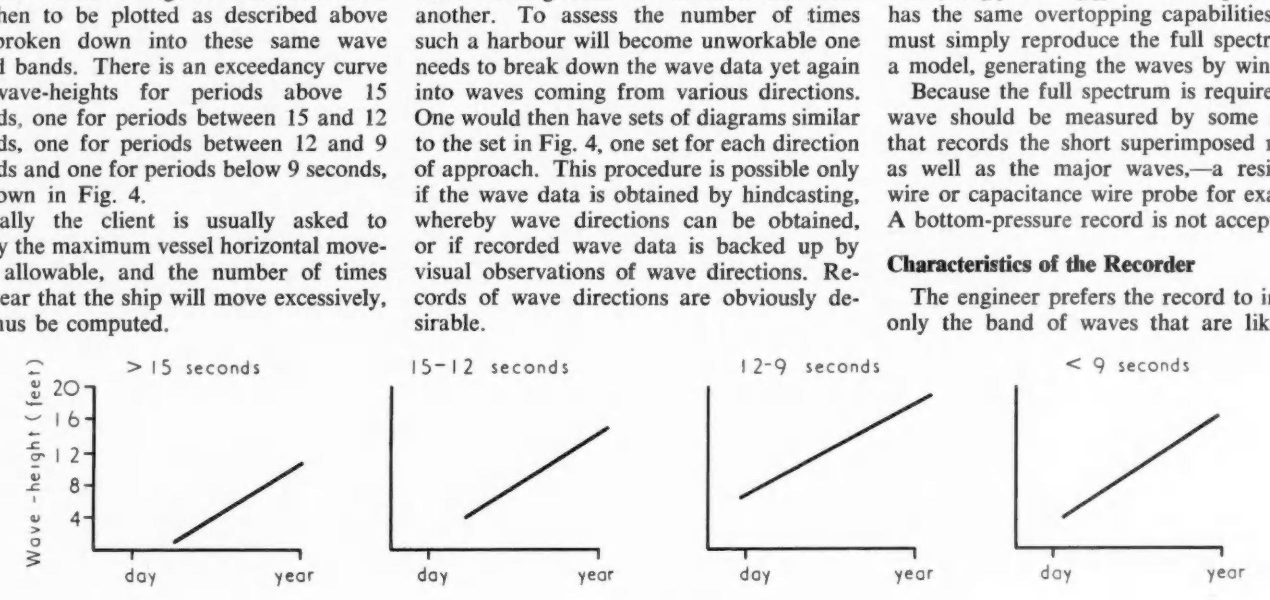
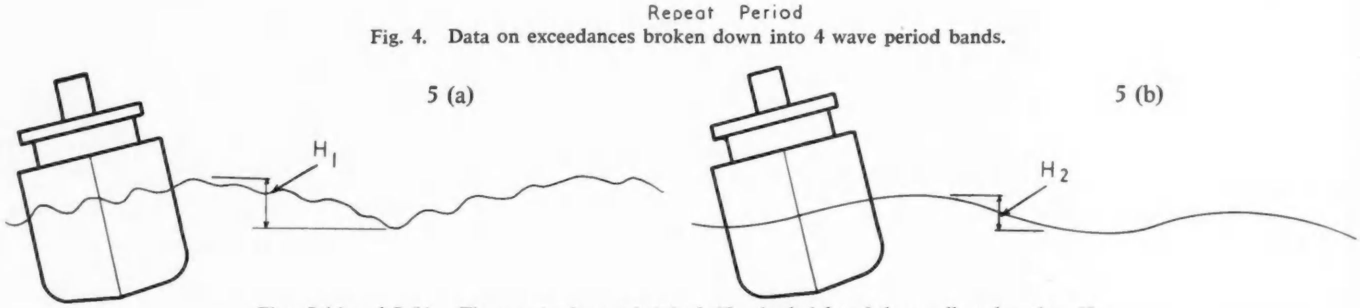


Fig. 4. Data on exceedances broken down into 4 wave period bands.



Figs. 5 (a) and 5 (b). The required wave height is H_2, the height of the swell, rather then H_1.

Example :

It is specified that 2 ft. horizontal movement renders a ship unworkable.

Referring to Fig. 3b we find that the corresponding waves at sea are :—

(a) 6.7 ft. high in the period band > 15 seconds.

(b) 10 ft. high in the period band 15-12 seconds.

(c) 13.3 ft. high in the period band 12-9 seconds.

(d) 20 ft. high in the period band <9 seconds.

Now looking at the exceedancy curves for the appropriate period bands as in Fig. 4 we find that

Wave (a) occurs 12 times a year.
(b) occurs 5 times a year.
(c) occurs 5 times a year.
(d) occurs once a year.

23 times

Long waves we treat in a very similar manner. A two-hour length of long-wave record is analysed in order to obtain the highest wave on it, and the period is taken from the average of the periods of the five highest waves. The finally obtained wave height can only be found after reference to the curve describing the characteristics of the built-in filter. Considerable errors can be introduced by a false choice of the wave period.

The wave disturbance inside harbours is relatively insensitive to the direction of long-wave approach, and a means of measuring the direction of long waves is not usually necessary.

Use of the Full Spectrum

Whereas normally engineers prefer to work with a single pure wave train, derived in some way from a study of complicated records, there are some problems where there

affect his structure. In particular he usually wants short waves omitted from the record as these merely confuse his measurement of the major wave. If for example he is concerned with measuring the waves that would move ships in a harbour and the waves are as shown in Fig. 5a he would prefer a record that omits the shorter waves that could have no influence on the ship. The wave shown in Fig. 5b has the same effect on the ship and he would prefer the record of the two waves to be the same. A record that reproduced the complete spectrum would reveal the fundamental wave, measured in the elementary way as the distance between the top of the crest and the bottom of the trough, to be higher than it was. Accordingly a bottom pressure record is often preferred to a surface record.

In the case of a long-wave recorder he requires waves both longer and shorter than those he is concerned with, to be filtered out.

It is very difficult to measure the heights of waves in the 1-4 minute period band from a record made on a machine having its maximum response at around 15 minutes and it is equally difficult to measure the long waves when the record is confused by short waves. Because of the difficulty of making accurate measurements of the period of long waves it is desirable for the response curve to be flat over the working range. The 1-4 minute band is the important one as regards the movement of ships in harbours by long waves, and it is over this band that he would like the response to be flat.

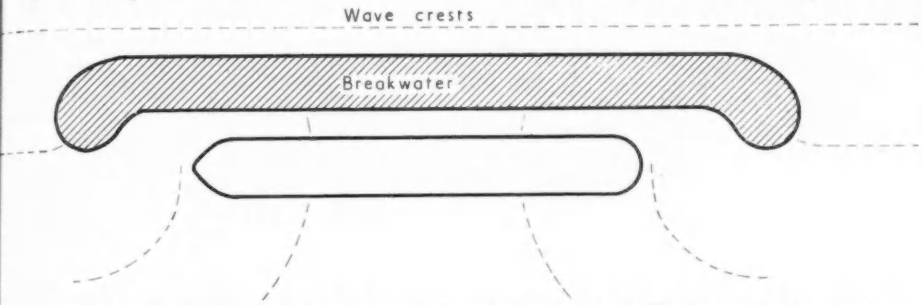


Fig. 6. A ship without any horizontal motion lying symmetrically in the lee of a breakwater.

Observations of Wave Directions

Information on wave directions has usually been obtained in the past from hindcasting, just as that is probably the most common procedure for obtaining heights and periods. Use has sometimes been made of wave observations from light-vessels. On other occasions the direction has been merely observed by someone standing on a cliff-top and estimating the alignment of the waves as they pass an assumed contour. A commonly required item of information is the net amount of sand passing along a coast in one direction and this has sometimes been obtained by use of the empirical formula

$$Q=210\,(P \sin \alpha \cos \alpha)^{0.8}$$

where Q is the instantaneous rate of littoral movement in cubic yards of sand per day, P is the power spent by the waves in millions of ft. lb. per foot of beach per day, and α is the angle between the wave-crests and the beach contour. The formula is much open to doubt and probably does not deserve to have very carefully obtained data fed into it. In which case cliff-top observations of wave direction are probably adequate.

Whereas a mean direction may sometimes be adequate, as for example in calculating the mean value of some function that varies linearly with direction; there are other cases where the variability is important. An example is shown in Fig. 6. It shows a ship moored in the lee of a short breakwater and protected by it from long-crested swell waves. When symmetrically located behind the breakwater the ship has no horizontal motion whatever, and it is normally possible, even when the waves meet the breakwater obliquely, to find a position for the ship where it will have no horizontal motion. On the other hand this is not possible if the direction of the waves is varying.

Limitations imposed by design of laboratory wave generators

At present the information on wave characteristics of which engineers can make use is rather limited. Calculations require a single value of the period, the height and the direction; and, because of the simplicity of our wave generators, this simple information is also required for hydraulic experimenting. Some advances are being made in the accuracy with which laboratory waves reproduce real sea waves: for example two wave basins at H.R.S. are equipped with generators that vary cyclically the period of the waves and produce on the beach the effect of a swell of varing height. Another generator is capable of producing two superimposed wave trains of slightly different period, the resultant of which is again a swell of varying height. Naturalistic waves can be reproduced in the laboratory by blowing wind over the water but because of the limited length of laboratory channels, the size of these waves is similarly rather limited. In the near future other, possibly rather small, improvements in the laboratory reproduction of sea waves can be expected.

With laboratory equipment in its present form use cannot be made of the full spectrum nor of data on the variability of wave direction. Records must be analysed in such a way as to get from them the single wave train most suitable for the particular design purpose.

REFERENCE

1. Longuet-Higgins M.S. 1952, On the statistical distribution of the heights of sea waves, *J. Mar. Res. 11*, 245-266.

Two American Built Dredgers

Constructed for Great Lakes and Mexican Waters

Details have been received of two dredgers which have been constructed in the United States. The first is the hydraulic dredge "Alaska" designed by the Erickson Engineering Company of Tampa, Florida and built by the Todd Shipbuilding Corporation of Houston, Texas, and the second is the sea-going, self-propelled hopper dredge "Frontera I" designed and manufactured by the Ellicott Machine Corporation of Baltimore, Maryland.

Hydraulic Dredge "Alaska"

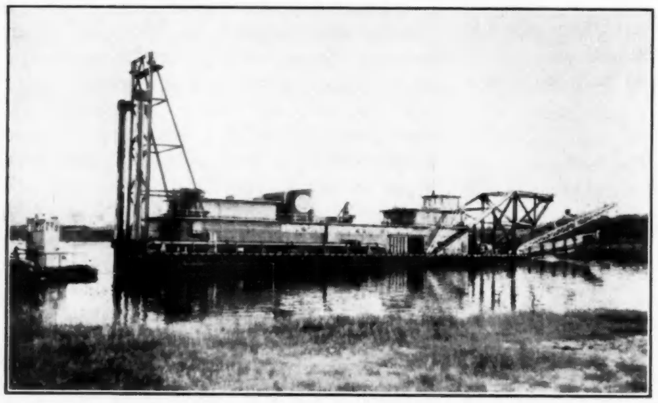
This vessel will be used for the time being on large dredging contracts on the Great Lakes. The hull of this vessel is 208-ft. by 46-ft. by 12-ft. 6-in. with a displacement of approximately 2,100 tons under average working conditions and the main deck house is 158-ft. by 31-ft. by 13-ft. The hull is provided with rake ends for easy towing and reduced current resistance and the house is strongly reinforced at stern for overseas towing. A craneway is provided the full length of the house for handling equipment in pump and engine room. The vessel conforms throughout to the American Bureau of Shipping requirements.

Dredge Ladder, Spud Gantry and Forward A-frame. The dredge ladder is designed for hard material dredging, including soft to medium hard rock. It is of sectional construction designed for dredging to 85-ft. and can, with section changes, dredge to 100-ft. if necessary. This spud gantry is designed for handling 40-in. diameter, 100-ft. long spuds, and is of sectional construction for removal when passing under bridges on rivers or inland waterways. The spuds are 100-ft. long of special heavy construction and can be extended for further length when required. The forward A-frame is designed for handling ladder lengths up to 115-ft. or 100-ft. dredging depth. In addition the design also includes inbuilt connections for the 125-ft. anchor booms, which are a special feature of large dredges designed by Erickson Engineering Co.

Dredge Pump, Cutter, Hoist Drives. The dredge pump is of Ellicott Machine Corporation special design, with extra width for passing large solids. Top speed of pump is approximately 360 r.p.m. Horsepower available is up to 6,000 h.p. with small overload depending on pipeline lengths and materials pumped. The cutter drive consists of two 600 h.p. D.C. Ward Leonard controlled motors capable of 50% plus overload for short periods. The motors drive the cutter through a double reduction gear, flexible coupling and thrust bearing. The cutter shaft

is 14-in. diameter of high alloy steel. The cutters, both for soft materials and rock dredging, are of Great Lakes Dredge & Dock Co. own design and the 4-drum swing gear is driven by a 200 h.p. D.C. Ward Leonard controlled motor permitting speed variation as required. The ladder is separately controlled by a double pick-up cable with both ends connected to a double drum. This makes for quick pick-up of ladder by a 200 h.p. A.C. motor, with necessary speed control.

The 3-drum spud gear is driven by a 150 h.p. A.C. motor, the



The dredge "Alaska" built for the Great Lakes Dredge and Dock Co., Chicago.

3-drums being required for use when dredging on anchors in exposed sea locations. The 3rd drum is also used when dredging in rivers during strong current conditions. In addition the ladder and spud drives are also furnished with 50 h.p. auxiliary motors for handling at reduced speed with auxiliary power plant, when the main power plant is shut down.

The dredge pump is driven by two 2,800 h.p., 800 r.p.m. General Motors super-charged engines. The auxiliary equipment is driven by one 2,800 h.p. General Motors Diesel, direct connected to three generators. The first is for driving cutter motors; the second for furnishing power for ladder and spud hoist motors, service pumps, air compressors, lights, etc. and the third for furnishing swing motor power. There are also two generator sets for furnishing auxiliary power when the large engines are shut down, and also one 3 cylinder Diesel for emergency use. All the engines are installed in the lower hold of the dredge. So also are all the heat exchangers, water service pumps for engine room and deck use.

Suction and Discharge Piping. The suction piping through ladder is 33-in. I.D., the discharge piping is 27-in. I.D. The discharge pipe is connected to the pontoon line with a standard type swivel elbow. The ladder suction pipe is connected to the hull suction pipe with a heavy duty rubber flexible. The centre line of suction pipe and dredge pump is approximately at the average waterline of dredge. This permits easy priming and cleaning of pump when required.

Equipment Handling on Dredge. In addition to the full length craneway which is fitted with two bridge cranes in the engine room for handling of engine and pump parts during repairs, there is also on top of deck house a full revolving 25 ton Le Tourneau crane for handling equipment and dredge pump parts through a hatch in top of the deck house. The anchor booms on each side of forward deck handle the swing anchors, thus eliminating for the most part, the need for tugs and derrick barges for this purpose.

The dredge control centre or lever room is located on top deck and is equipped with all the latest indicators and aids for obtaining top production. The dredge operator or leverman has full vision all around the dredge and can efficiently handle all operations from this centre.

The latest labour saving devices for economy of operation under all conditions have been provided. For short pipelines and easy pumping material, one of the main pump engines may be shut down and the dredge pump operated with a smaller impeller or at reduced speed. On long pipelines and in heavy pumping materials with both engines operating a maximum of up to 6,000 h.p. may be obtained for short periods. The dredge ladder is of sectional construction which can be quickly adapted to either shallow or deep dredging. Under favourable conditions in soft materials the vessel will produce up to 4,500-cu.yds. per hour. In soft to medium hard rock 200 to 1,500-cu.yds. per hour. In good pumping materials the dredge will pump on pipelines of 18,000-ft. or longer if necessary.

Hopper Dredge "Frontera I"

This dredge will principally be assigned to the Port of Frontera in the State of Tobasco for maintaining the entrance channel to the Grijalva River. The Port of Frontera is the principal access for ocean navigation to the state through which flow the Grijalva and Usumacinta Rivers which are navigable for shallow draft barges and other types of marine vessels. The development of the Port is planned to be carried out simultaneously with large public and private improvements which will stimulate the commerce of this potentially rich region.

A sister unit to the "Frontera I" is at present under construction for the Dredging Department of the Navy, United States of Mexico and will be completed later this year. The "Frontera I" will sail to Mexico in the near future and will proceed directly to the Port of Frontera to begin dredging operations.

This dredge has a length overall of 186-ft. 2-in., a moulded beam of 35-ft., a moulded depth of 16-ft. and a loaded draft of 12-ft. Having a capacity of 500-cu.yds., the hopper space is divided into two compartments by a transverse bulkhead. These compartments are further subdivided transversely and longitudinally into four hopper units giving a total of 8 units in all.

The dredge is equipped with two Ellicott 14-in. dredging pumps and their capacity is such that the hoppers of the dredge can be filled in approximately 30 minutes. The maximum dredging

The hopper dredge "Frontera I" built for the Mexican Government.

depth is 30-ft. The ship has a speed of approximately 11½ knots with the hoppers empty and 10 knots with loaded hoppers. Its propulsion engines are two Caterpillar Marine diesels, Model D-397, with a combined maximum HP of 1,250 in the shaft at 1,200 r.p.m. Each dredge pump is powered by a Caterpillar Model D-375 diesel engine having an operating ratio of 300 s.h.p. at 1,200 r.p.m.

The dredge is equipped with quarters and galley to accommodate a crew of 33 officers and men.

New Transit Shed for Bananas at Port of Hamburg

Development of Improved Handling Methods

(Specially Contributed)

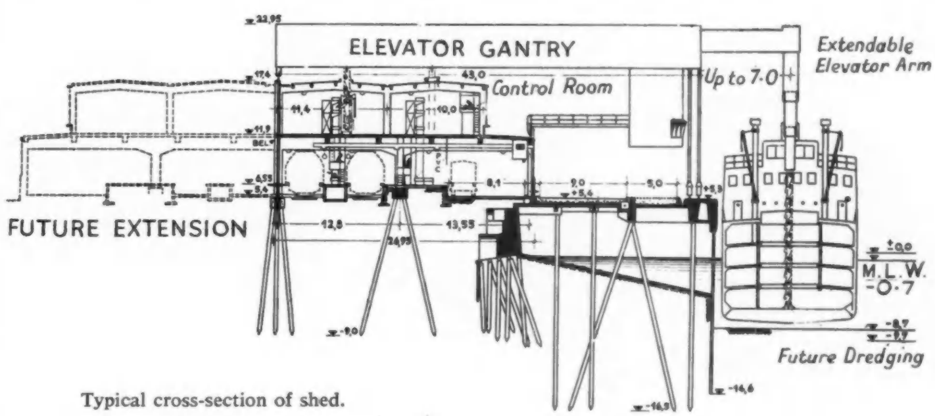
Introduction

West Germany's imports of fruit, especially bananas, are mainly channelled through the Port of Hamburg. The original banana handling facilities of the port, which were constructed in 1936, did not survive the war. During the immediate post-war years makeshift solutions were employed until 1950, when the volume of banana imports handled by Hamburg had almost reached the peak pre-war figure (about 80,000 tons a year) and it became imperative to equip a rebuilt transit shed for the specific purpose of dealing with this fruit.

The further rapid growth of the banana import trade—by 1959 some 300,000 tons a year were being unloaded at Hamburg—soon made these facilities inadequate, however. In particular, they did not permit more than one banana vessel at a time to be unloaded at the shed. As it not infrequently occurred that two such vessels arrived in the port at more or less the same time, delays were caused. The waiting periods involved were deleterious to the condition of the cargo, as bananas are very susceptible to rapid deterioration.

To meet the requirements of the situation, a start was made, in 1958, with the design of a new transit shed designed specifically for handling bananas. Construction commenced in the early part of the following year. The new facilities had to embody the highest possible degree of mechanisation in order to keep labour costs down to a minimum. The effective length of quay associated with the new transit shed is about 290 m., with berthing accommodation for two vessels; the depth of water provided is 8 m. at mean low water. The equipment of each berth comprises five up-to-date banana elevators, as well as some level-luffing cranes for general cargo handling (loading return freight for banana vessels, and incidental duties).

The elevators convey the bunches to the upper storey of the two-storey shed, where the over-ripe bananas are removed before the fruit is taken by belt conveyors to the loading platforms where it is transferred to road or rail vehicles for transport inland. These loading platforms run the entire length of the ground floor of the building. They enable loading operations to be carried out on 16 railway waggons at a time, besides providing approximately 250 linear metres of loading space for lorries.



Typical cross-section of shed.

In order to keep the handling operations of each berth entirely separate from those of the other, the whole shed has been subdivided longitudinally into two parts, each half of the building with its equipment being assigned to one particular berth. As a first stage in the execution of the scheme, only one half of the shed has been built, namely, the half nearest the water's edge, and only one of the two berths has, as yet, been equipped with elevators. The total cost of this first stage, comprising half the shed with its mechanical handling equipment, the entire quay wall (comprising two berths, only one of which is at present being used for the unloading of bananas), and the necessary road and rail facilities, was in the region of 16 million DM.

Road and Rail Transport Facilities

Bananas are an extremely delicate species of fruit. As a rule, they are imported in special air-conditioned vessels carrying an average cargo of between 1,500 and 2,000 tons per vessel. Throughout the sea voyage, which usually lasts about a fortnight, the fruit is kept at a temperature of +11°C., and it is essential approximately to maintain this temperature during all handling operations at the port and in subsequent transit to inland destinations. For this reason special temperature-controlled lorries and railway waggons are employed. To protect the bananas from damage by bruising, it is necessary to pad the lorries and waggons with straw before the fruit is loaded into them. In general, the bananas must be transferred from the ship to the lorries or waggons without intermediate storage. This requirement makes high demands upon the capacity and efficiency of the road and rail transport facilities to be provided.

At Hamburg, extensive railway sidings have had to be constructed, in conjunction with adequate weighing facilities for coping with the large quantities handled (about two-thirds of the bananas unloaded at the port are despatched inland by rail). Suitable provision has also had to be made for the traffic of road vehicles to and from the new shed.

Empty railway waggons for the transport of bananas are first despatched to three sidings, each about 800 m. long, where they are lined with straw. The waggons are then shunted on to sorting sidings and are weighed by automatic weighing machines while in motion. They are then taken, suitably grouped in sets of 16, to one of the two loading tracks in the shed, these tracks being situated on either side of a loading platform. Loading the bananas into the waggons takes place on alternate sides of this platform, one set of loaded waggons being removed and replaced by empties while the set on the other track is in process of being loaded. On an average, it takes about half an hour to load a set of waggons. On leaving the shed, the loaded waggons are again weighed.

The lorry-loading platform, like the platform for railway waggons, is accommodated within the shed. Appropriate facilities for weighing the empty and laden lorries are likewise provided.

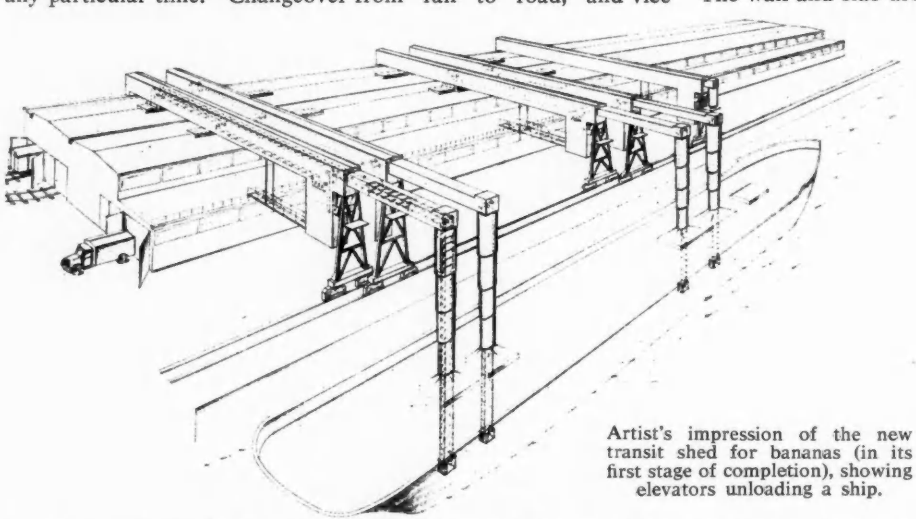
Mechanical Handling Facilities

The special mechanical handling plant with which the new transit shed is equipped has been developed by the German engineering firm of MIAG, Brunswick, in consultation with the Hamburger Hafen- und Lagerhaus A.G., the promoters of the scheme.

Loading the bunches into railway waggons is done from a longitudinal belt conveyor running the length of the platform. The elevators unload the fruit from the ship's holds and discharge it on to auxiliary feeder belts which in turn deliver it to the main

longitudinal belt at different (and adjustable) points. A drawback of earlier banana handling installations had been the fact that a railway track was provided only on one side of the loading belt conveyor. This arrangement involved appreciable delays corresponding to the amount of time it took to remove the loaded waggons and bring a fresh set of empty waggons into position alongside the conveyor. In the new installation at Hamburg there is a track on each side of the conveyor, which is situated centrally on the platform and runs the entire length thereof. In this way the loading operations can be conducted as a continuous process, one set of waggons being loaded while the already loaded waggons on the other track are withdrawn and replaced by empty ones. A similar belt conveyor, likewise fed by auxiliary conveyors, is installed on the lorry loading platform.

Each of the five elevators is so designed as to be able to deliver the bananas either to the conveyor for railway waggon loading or to the lorry loading conveyor, depending on the requirements at any particular time. Changeover from "rail" to "road," and vice versa, is achieved with the aid of a special traverser device within the building, at the landward end of each elevator. The elevators, in conjunction with the various conveyors and auxiliary devices for permitting positional adjustment of the feed and discharge points, form a complex and ingenious system of mechanical handling plant.



Artist's impression of the new transit shed for bananas (in its first stage of completion), showing elevators unloading a ship.

On its way from ship to shed the fruit must never be exposed to cold or draughts. For this reason the elevators are totally enclosed and capable of being heated with warm air. To meet the requirement that it should, when necessary, be possible for any two elevators to be brought close enough together to unload bananas from the same hold, it was necessary to install two running rails along the edge of the quay. The waterside supports of the alternate elevators are mounted on track wheels running on the inner or the outer rail respectively, so that these supports —which have to be of sufficient width to provide the desired structural stability in the longitudinal direction of the quay—can "overlap" one another.

The length of the arm projecting from the waterside end of the elevator gantry is adjustable while the plant is in operation, without altering the length of the elevator chain, fitted with pocket type receptacles for the bunches of bananas, which is suspended from this arm. The arm has a maximum outreach of 12 m., thus enabling the chain to be given any position within the hold of even the broadest vessel. The correct height of the chain in relation to the height of the vessel (which varies in consequence of tidal movements and as a result of the unloading operation itself) is automatically maintained by a special control mechanism. The suspended portion of the elevator chain is enclosed in an extendable sheath consisting of telescopic tubular sections made of a transparent plastic. The elevator gantries have an insulated galvanised sheet-steel cladding. The operation of inspecting the bunches and rejecting or cutting out over-ripe and rotten bananas is carried out on the auxiliary belt conveyors.

The Shed

The new transit shed is situated near the end of one of the "finger" piers of the Hamburg dock system. To accommodate the shed, the pier had to be locally widened. This was done by building a new quay wall some distance in front of the existing wall. The space between the two walls was, in part, filled with sand and was bridged by a concrete deck slab forming the apron before the shed. The construction of the quay wall superstructure and apron slab involved the use of about 4,960 m^3 of concrete, 260 tons of reinforcing steel, and 1,000 tons of steel sheet piling. The wall and slab are supported on 630 reinforced concrete piles of 34 cm. × 38 cm. section and 21 m. average length. The quantity of concrete used in making these piles, which were precast on site, was about 1,800 $m.^3$

The transit shed itself is founded on 328 reinforced concrete piles of 34 cm. × 34 cm. square section and generally 14 m. in length. The building is 250 m. long, comprising 30 bays of 8·33 m. Its width at ground level is approximately 27 m., accommodating two parallel railway tracks with a loading platform between them, a roadway 8·10 m. wide for lorries, and a lorry-loading platform. Each platform has an effective length of 210 m. The upper storey of the shed is approximately 22 m. in width. Its roof is provided with slots about 33 m. long and 1·40 m. for the elevators. These slots can be closed with insulated panels made of galvanised sheet steel. The building has a reinforced concrete structural frame.

Thermal insulation was a major consideration in the construction of the walls and roof of the shed. The roofing consists of 8 cm. thick lightweight concrete slabs covered with 3-4 cm. thick cork panels bonded to them, which in turn are covered with two layers of roofing felt. Thermal insulation of the waterside external walls is provided by a lining of lightweight concrete blocks applied to the inside. The rear (or landward) wall of the shed—the future central dividing wall between the two halves of the structure when it is subsequently extended—is of 30 cm. thick reinforced concrete. It is lined with quilted mineral-wool mats for insulation. Daylighting is provided on both floors by wide strips of puttyless glazing (wired glass).

The shed is heated by high-pressure gas heating units, the warm air being passed through ducts and discharged over the auxiliary and loading belt conveyors. In summer, the same installation enables fresh air to be drawn in from the cool north side of the building and distributed throughout the interior. The entrance and exit doorways for road and rail vehicles are fitted with large pneumatically operated doors, which are normally kept closed and are opened only to permit the passage of vehicles. In addition, "warm air curtains" are provided at these doors in order to prevent waves of cold air from entering the building when they are opened.

The upper floor of the shed contains the central control room from where the entire mechanical handling system can be super-

(Continued at foot of following page)

Metallurgical Developments and the Dock and Harbour Engineer

by L. SANDERSON.

This has been a remarkable year for the number of new advances which have been made in metallurgical materials and processes, many of which must be of value and interest to the dock and harbour engineer. In the following lines, some of the more important of these are briefly summarized.

Foamed aluminium is a new material which has a very low weight, a low melting point, good mechanical properties and good workability. It can be cast into thin sections (½-in.) and into large sections without distortion. It can be cut with either a bandsaw or a handsaw. Assemblies can be made by nails, screws, bolts, welding or adhesives. It is a good insulator, is resistant to corrosion, and also resistant to fire. Many applications have already been suggested, namely to wall panels, small boat construction, shipping boxes and containers for fragile equipment, roof decking, trailer walls, etc.

Bridge designers today use low alloy, high strength steels in a large number of their designs, and in one area, virtually all the highway bridges are of welded construction. Two grades of high strength steels are being used for this work; weldable steels and a complex nickel, chromium, molybdenum, vanadium steel. Some of the major bridges embodying these steels contain about 3,000 tons of the complex alloy steel.

Revolutionary Alloy Steel

A revolutionary new 18 per cent nickel alloy steel with unmatched toughness at the highest strength levels of traditional alloy steels has been discovered and developed. It is considered to be the pioneer of a new range of high strength steels with advanced engineering design possibilities for applications involving exceptionally high pressure and stress. It is said to be the only known material capable of giving a yield strength in excess of 112 tons/sq. in. while maintaining a nil ductility temperature below −62 deg. C. Another outstanding property of this steel is its excellent notched tensile strength, which exceeds 180 tons/sq. in.

The new alloy steel has a remarkable resistance to delayed cracking when exposed to a severe corrosive atmosphere in a highly stressed condition. It develops its high strength while maintaining unequalled ductility and toughness by means of a surprisingly simple heat-treatment involving age-hardening, and known as 'maraging'. The new steel has a nominal composition of 18% nickel, 7% cobalt, 5% molybdenum, less than 0.5% titanium and a maximum of 0.05% carbon. Higher and lower tensile strengths can be obtained by modifying this basic composition. Extensive cold forming and shaping present no difficulties. Machining properties are said to be excellent, and welding is readily carried out. A patent application has been filed.

In many applications, the suitability of a material for use as a fastener is controlled by the extent to which it can satisfy one or more of such requirements as corrosion resistance, heat resistance, high strength and toughness, hardness, abrasion resistance, machinability, and non-magnetic or special electric properties. Great advantages in this respect are now offered by the wide range of high nickel alloys commercially available. New varieties of Monel metal, and Inconel, which are high nickel copper alloys, as well as new or comparatively new alloys such as Nionel and low carbon nickel, have all been found valuable in fastenings for applications involving exposure to marine environments, the material being chosen according to the specific function.

An alloy containing 6 per cent manganese and 1 per cent molybdenum has been designed for use where a moderate degree of toughness combined with a high degree of resistance to abrasion is required. It is believed to have better wear resistance than ordinary 12-14 per cent mangenese steels, while retaining good ductility and toughness, ease of heat-treatment and freedom from high residual stresses in heavy sections. It is already being used in many applications such as chute liners for handling coarse ore, but it is not equal to the standard austenitic manganese steel in ductility, tensile strength or impact strength, and should not be used where premature failure by breakage owing to high stresses or high impact is probable.

New Dredging Plant Steels

Austenitic mangenese steels are widely used in parts of dredging and other equipment used in docks, and therefore it is important to note that two new steels of this type have been developed to provide higher resistance to abrasion in castings. Both steels are alloys of manganese and molybdenum. One combines toughness, abrasion resistance and ductility. The other provides exceptional abrasion resistance, but only moderate ductility. Increased molybdenum content in the steels allows of a higher carbon content than is normal in the austenitic manganese steels at present employed.

In Japan the mechanical, wear-abrasive properties and work-hardenabilities of austenitic manganese steel castings containing 0·68% to 1·78% carbon, 8·44% to 12·46% manganese, have been investigated. It was found that mechanical properties were best with a ratio of manganese to carbon of 10, but wear-abrasive properties were best with a manganese/carbon ratio less than 10. Even austenitic manganese steel castings with relatively low manganese content had quite good work-hardenability.

The strength of ultra-high-strength steels of martensitic type is achieved primarily by means of carbon. Ductility and toughness, however, are inevitably reduced in proportion as carbon content increases. If large increases of strength are to be achieved in the future, new means of obtaining strength without further loss of ductility must be obtained. One such method recently developed is a mechanical-thermal processing technique known as the 'Aus-form' process. This involves structural modification of the steel by the addition and balance of elements such as chromium and nickel, by a process of plastic deformation of metastable austenite in a specific area of transformation, and a later transformation to martensite, the hard constituent of carbon and other steels.

The greatest strength of these new 'Ausform' steels is attained with relatively high carbon content and maximum austenite

New Transit Shed for Bananas

(*continued from previous page*)

vised and controlled with the aid of lighted indicator panels, counting devices, etc. The shed is equipped with its own system of fire-fighting mains. Efficient lighting has been installed, particularly over the loading platforms and the sorting belts where the over-ripe fruit is removed. An annexe at one end of the building provides office accommodation and other facilities for the personnel engaged in the operation of the shed and for employees of the banana importing firms concerned.

The total cost of the new installation (in its first stage of completion), which was put into commission in February 1961, was approximately 15·5 million DM. This figure is composed as follows: 4·35 million DM in respect of the shed, with a further 0·75 million DM for the office annexe; 3·8 million DM in respect of the mechanical handling plant; the new quay wall cost 3 million DM; and the provision of suitable road and rail access, sidings, weighing machines, auxiliary installations, etc. entailed an expenditure of around 3·6 million DM.

deformation. To illustrate this, a steel containing 0·60 per cent carbon deformed 93 per cent had a yield strength of about 180 tons/sq. in. and an ultimate tensile strength of about 104 tons/sq. in.

During recent years, it has been emphasised that design should employ the full potential of steel, so saving weight and expense. Trucks, trailers, and other dockside equipment need weight reduction combined with greater robustness, so that they can achieve a bigger payload. An answer to this problem is the new die quenching equipment, which allows the side rails up to 40-ft. long of trucks, etc., to be made from a low carbon steel, which nevertheless gives a yield strength averaging about 52 tons/sq. in., and a tensile strength of 57 tons/sq. in. Elongation is of the order of 17 per cent. The steel, which contains 0·22 to 0·28 carbon, 1·00 to 1·35 manganese, per cent, is readily welded. The new equipment is said to eliminate laborious straightening after heat-treatment of the channels.

Another arresting development is the introduction of a range of columbium-treated, low carbon, semi-killed steels. The columbium (niobium) is added to low carbon steels to increase their strength, preserve their excellent weldability at higher strength levels, to provide good formability, and to give a level of toughness claimed to be equal to or better than of low carbon steels.

Stainless Steel Alloys.

The commercial production of bright, annealed stainless steel has been announced in the United States, which claims it as a major improvement in the surface lustre and corrosion resistance of the material.

One of the great handicaps of stainless steel has been the difficulty of machining it. The addition of a little extra sulphur has improved machinability to some extent, but this seriously lowers resistance to corrosion and formability. It has now been found that if the sulphur content is reduced to 0·13 per cent and 0·7 per cent aluminium is added in its place, there is a marked improvement in machinability without the harmful effects on corrosion resistance. The improved performance of this alloy includes higher output of machined parts, longer tool life, and improved surface finish, as well as increased formability, so that threads can be rolled on it. Fasteners, valves, fittings, etc., are typical applications.

A new 'super-weldable' stainless steel alloy is said to be on its way. It will be a crack-resistant chromium nickel stainless steel with alloying agents designed to prevent cracking during metal solidification, as in welded and cast parts. A new martensitic alloy cast iron which is hard, yet not very brittle, contains 5·5 to 6·5 per cent chromium.

Certain special steels have been developed for improved resistance to oxidation at elevated temperatures. Among these is a 15 per cent chromium, 35 per cent nickel steel, which can be used at temperatures up to 980 deg. C.

New Welding Techniques.

There have been some important advances in welding. Electron beam welding, for example, is new. It consists of bombarding the surface of the workpiece with a concentrated beam of fast-moving electrons which produce sufficient heat for welding to take place. The process has a number of advantages. The welds have virtually no contamination. There is close control of penetration, as well as low thermal distortion and close dimensional control. The major drawback is that the welding operation has to be done in a vacuum, which restricts the versatility of the process. Workers must also be protected from harmful radiation.

The U.S.S.R. have developed the technique of friction welding in which the metal of the weld joint is heated to its plastic state by the friction of the two butting surfaces revolving against each other under pressure. As soon as a temperature (for steel) of 900 to 1,300 deg. C. is reached, relative motion is arrested, and the work is allowed to cool, the clamping pressure being maintained. The tensile strength, ductility and impact properties of such welds are said to be equal to or even better than those of the base metal.

Another recent development is the electroslag welding process, which is an arcless type of electric welding in which a molten slag, resisting the flow of an electric current, creates a high temperature. This melts both the consumable electrode and the adjoining base metal. Welding must be done in the vertical position, with sliding, water-cooled shoes spanning the weld path to maintain a pool of molten metal and slag between the parts being welded. The process is said to be best applied to heavy plates.

Paints and Coatings.

Paints that can be applied as base coats directly on to steel even when the metal is dirty and rusty, have resulted from a British invention. The paints take advantage of the rust. A metal powder in the paint converts the rust to magnetite and in effect, swallows it up.

A new chemical surface treating process, which for the first time colour-coats almost all metals in a single treatment is now ready for commercial application. The new coating is produced in several grades, clear and coloured, which are corrosion resistant, have good weathering properties, and are colour fast. The process is said to combine ease of application with good resistance to corrosion at economical cost. The coatings produce attractive satin and colour finishes, are resistant to acids, alkalis and solvents, and it is claimed that the colour coatings are much more economical than colour anodizing or painting. They are applied in water solutions at room temperatures. The only pre-treatment required is a thorough cleansing and rinsing, as in any finishing system. Curing time can be as little as a few seconds, according to the source of heat. Three coatings are available. The colour finishes are hard, solvent-resistant and ductile, and also durable. They resist salt spray, and when exposed to a sub-tropical sun for a full year and 2,000-hr. weathermeter tests, they exhibited good weathering, fade resistance and gloss retention.

A new metallic paste has been developed for the long-term rust-proofing of iron and steel. The paste liquefies when applied, then solidifies within six hours to form a metal coating. Two coats are claimed to deposit approximately ½ kg. metal/square metre.

Steel wire has been greatly developed. In a short article it is impossible to give more than bare details of some of the more important advances, but it can be said that modern steel wire has improved adhesion properties, and is being coated, clad and combined with other metals for better performance. Aluminium-coated wire, for example, is said to withstand corrosion from three to five times as long as galvanised metal. Wire-reinforced concrete is being increasingly used. The tensile strength of wire has been increased, and scientists declare that a wire with a strength of 70,000 kg./sq.cm. will soon be available. Automobile grilles of heavy steel wire mesh are another advance soon to be available.

A new high carbon steel wire is being produced with a tensile strength of over 200 and more tons/sq. in. It is available in diameters as low as 0·005-in. and finer. The tensile strengths are somewhat lower in larger sizes. The wire is fabricated with plastic binders to form high tensile members.

Telescopic Caisson Lighthouses off the Coast of Sweden

Extensive Use of Prefabricating Technique*

(Specially Contributed)

Lightships and lighthouses play a very important part in marking the numerous islands, reefs and shoals of Sweden's long coastline. Before the advent of winter, lightships have to be towed into port and cannot be returned to their summer moorings until the coastal waters are free of ice. It is chiefly for this reason that a number of lightships have, in recent years, been replaced by lighthouses located in the open sea. These have the advantage of remaining in operation all the year round and being cheaper to maintain than lightships. Access to the lighthouses in winter has been greatly facilitated by the provision of helicopter landing platforms on these structures.

The offshore lighthouses are founded in depths of water ranging from about 5 m. to 14 m. The method of construction that has been evolved for them in Sweden consists in prefabricating them as far as possible on shore, in the form of caissons, and towing them to their place of destination, where they are sunk and completed. This method has the great advantage of eliminating most of the risks entailed by constructional operations in the open sea and facilitating the work generally. This in turn enables substantial savings to be effected in the cost of construction. With the technique as at present employed, all the heavier items of mechanical and electrical equipment of the lighthouse are installed before the caisson is launched, and the living quarters for the attendants are likewise fitted up in advance.

The first caisson type lighthouse was built in 1951-1953. This structure, named the Hällgrund lighthouse, was installed in 4 m. of water. The sea bed at this site consisted of granite, and a level base for the caisson was formed by blasting the rock. In addition, holes were drilled for the tie-rods serving to anchor down the lighthouse structure. Anchorage was necessary because in this case the caisson forming the foundation was only 8 m. in diameter at the base, and the superstructure would be exposed to wind pressure (150-250 kg/m^2), wave action, and ice pressure. The loading due to ice pressure, in particular, was severe, being estimated at 50-100 tons per metre acting at a height of about 0·50 m. above water level.

The caisson for this lighthouse was constructed on shore—at Stockholm, 250 km. from its final destination—and lowered into the water with the aid of a crane. It was 4·50 m. high and was provided with a temporary timber bottom to enable it to float. At the offshore site it was sunk by flooding and came to rest on three concrete plinths cast on the prepared bed. After removal of the timber bottom, low walls of sandbags were built inside and outside along the circumference of the caisson. The gap between these walls was filled with concrete, whereby the caisson was bonded to the rock bed. It was then pumped dry, and the remaining work of building the lighthouse was carried out.

Subsequent development of the caisson principle led eventually to the prefabrication of virtually the entire lighthouse structure on shore. In this way the expensive and hazardous work of completing the lighthouse at sea was largely eliminated. On the other hand, considerations of stability ruled out the possibility of towing a complete and fully erected lighthouse to its offshore site. This problem was overcome by the introduction of the "telescopic" method of construction, which consists in building two or more caissons concentrically one inside another. At the site of the future lighthouse the outer caisson is sunk by ballasting, and the inner caissons are then raised by pumping in water. They are finally fixed in the raised position. To Mr. Robert Gellerstad, Chief of the Lighthouse Building Department of the Swedish Board of Navigation, and his team must go the credit for conceiving and developing this technique.

The first lighthouse to be built by the "telescopic" method (in 1958) was the Grundkallen lighthouse in the South Bothnian Sea. It was completed in eight months. The caissons were constructed at Stockholm, about 180 km. from the site of the lighthouse. The outer, or supporting, caisson has an external diameter of 18·20 m.; its peripheral wall is 9·25 m. high. The inner wall of this caisson is 13·00 m. in diameter and rises to a height of 14·30 m. above the base, i.e., the sea bed, which consists of granite and was levelled by dumping rubble on it a short time before the caisson was floated into postion and sunk. The depth of water is 7 m. The annular space between the outer and the inner wall of the supporting caisson is subdivided into six buoyancy compartments. Within this caisson is installed the second caisson, 12 m. in diameter and 12·20 m. high, which forms the lower part of the superstructure of the lighthouse and was precast on shore (along with the supporting caisson). In its final (raised) position it rises to a height of 23 m. above base level. Surmounting this

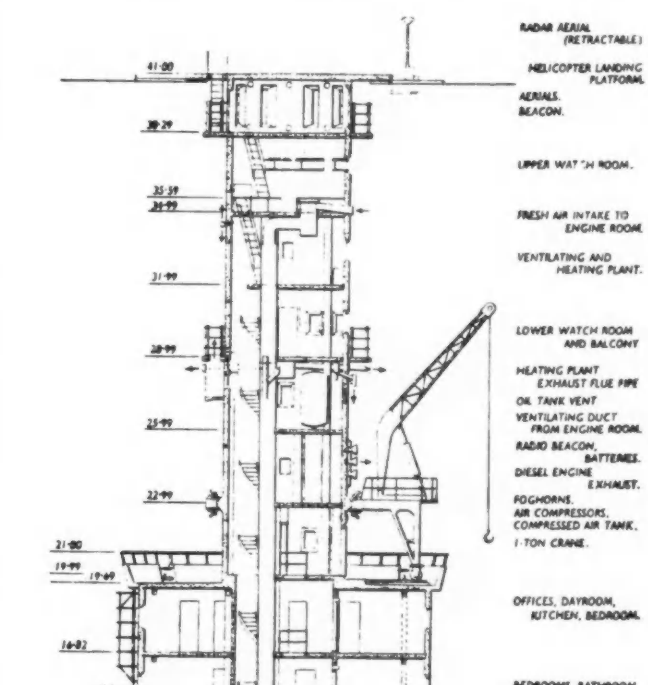


Fig. 1. Sectional elevation of Grundkallen lighthouse.

* Based on information supplied by Mr. R. Gellerstad, Chief of the Lighthouse Building Department of the Swedish Board of Navigation, Stockholm.

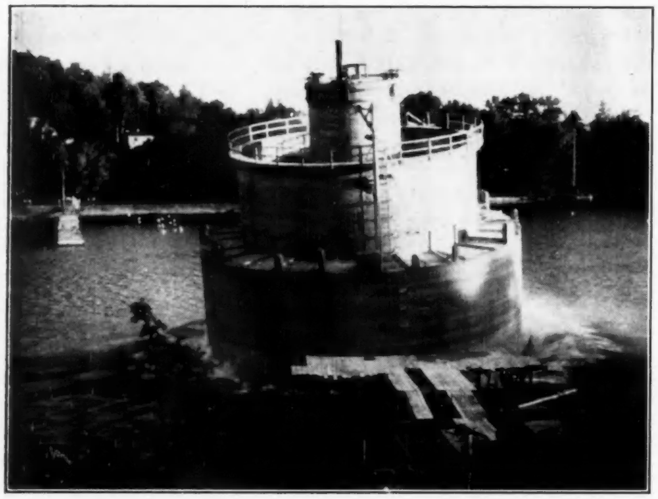


Fig. 2. Launching the telescopic caissons for the Grundkallen lighthouse.

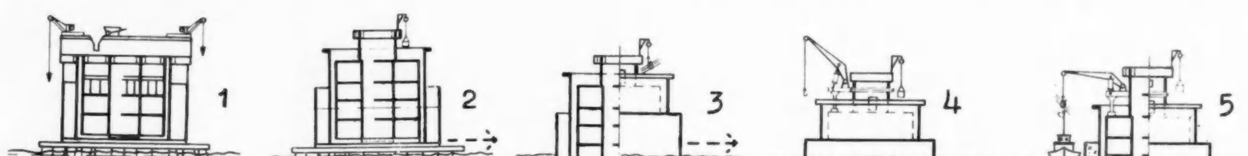
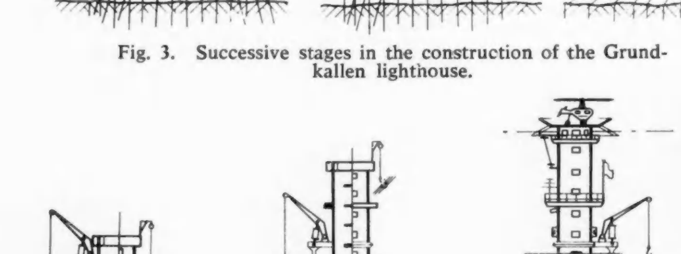


Fig. 3. Successive stages in the construction of the Grundkallen lighthouse.



inner caisson is a cylindrical shaft, which was constructed in situ and attains a height of 41 m. above the sea bed.

The lower part of the superstructure comprises four floors with a central circular stair well. Each of these floors has six rooms arranged around the staircase. The two bottom floors accommodate mechanical installations; the lighthouse attendants' living quarters are on the two upper floors.

The caisson set—comprising the inner and the outer caisson—was constructed on a timber platform built on 165 timber piles driven into the bottom of a small harbour near Stockholm. Concreting was begun in January 1958, at temperatures sometimes falling to $-10°C$. A total of 413 m^3 of concrete was placed. On completion of the caissons, the power-generating equipment (three diesel-electric sets), the heating and ventilating plant, heat exchangers, pumps, oil and water tanks, sanitary installations, lighting, cooking facilities, and a temporary radio station were installed.

The caisson set, with an overall weight of about 1,650 tons, was launched by removing the outer raking piles on the seaward side of the platform (they were blasted with explosive) and additionally applying a 140-ton horizontal thrust by means of a jack. This caused the piled platform to collapse into the water. When the caisson set had been towed to its site out at sea, it was sunk on to its levelled base by flooding the compartments in the outer caisson. Next, water was pumped into the space between the outer and the inner caisson, causing the latter to rise at a rate of 1·5 m. per hour. When it had reached the correct final height, it was fixed to the outer caisson so as to form an integral whole with it. The flooded compartments in the outer caisson and the space beneath the inner caisson were filled with graded stone. All the stone fillings were subsequently injected with cement grout ("Prepakt" method). The cylindrical shaft carrying the actual beacon was then completed in situ (i.e., from a level of +23·00 m. upward).

Since the construction of the Grundkallen lighthouse, four more lighthouses have been built on the telescopic caisson principle. In these structures a further improvement was introduced in that the proportion of work to be executed after sinking the caisson in its final position was reduced still more. Two of them,

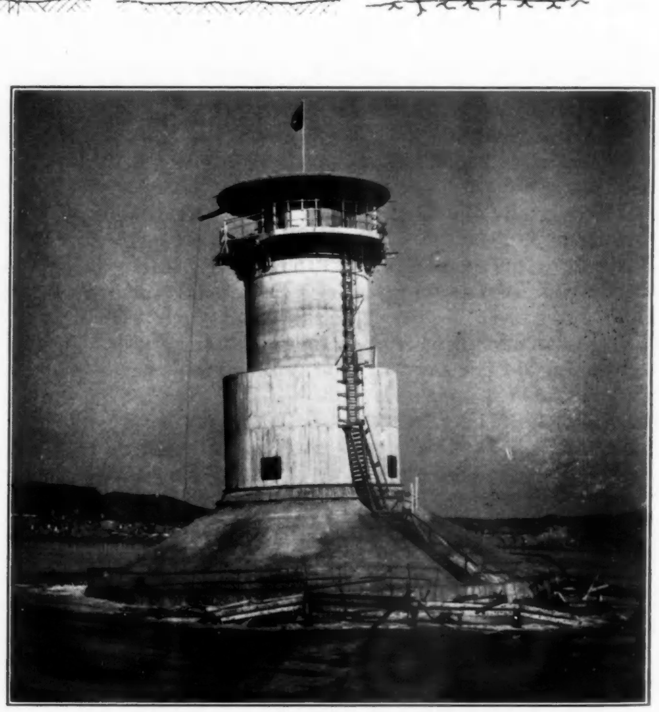


Fig. 4. Nordvalen lighthouse just after launching.

the Nordvalen and Svindbaden lighthouses, are unmanned structures, almost identical in design. These lighthouses were entirely prefabricated, almost the whole of the constructional work having been completed on shore before the launching of the caisson set. Next came the Sydostbrotten lighthouse, a larger structure situated at a spot where the water is 10 m. deep. The super-

structure of this lighthouse rises to a height of 33·5 m. above water level. The outer caisson has an external diameter of 23 m. The caisson set for this lighthouse was launched in May 1960. Its weight was initially some 2,600 tons. Before undertaking the sea voyage to its final destination, it was filled with more concrete, with the result that its weight was increased to around 3,500 tons and its draught from 6·2 m. to 8·5 m., thus increasing the stability of the floating unit. In general, the design and constructional procedure were almost identical with those of the Grundkallen lighthouse, except that the shaft carrying the beacon was completed before the caisson set was launched.

The most recent of these telescopic structures is the much smaller Revengegrundet lighthouse, which is located in 7 m. of water on the Revengegrundet, a shoal off Stockholm named after the British warship "Revenge" which ran aground on it almost exactly a hundred years ago. The caisson for this lighthouse was sunk in its final position in May of this year. The outer caisson is 11·00 m. in diameter and 8·50 m. in height. The constructional procedure adopted was novel in that the outer caisson, the inner caisson (3·90 m. diameter), and the cylindrical shaft (2·56 m. diameter) carrying the beacon were concreted separately from one another. With the aid of a crane the inner caisson was then lifted up and lowered into the outer caisson and finally, by the same means, the shaft was installed within the inner caisson. When the outer, or supporting, caisson had been sunk by flooding, the central shaft was raised a distance of about 9 m. by pumping water into the inner caisson and by the use of hydraulic jacks.

New Oil Terminal at Granton

The new ocean oil terminal at Granton near Edinburgh is now fully operative. Built for the Regent Oil Company and costing over half a million pounds, it will replace the existing storage facilities at Grangemouth. This new installation, which will provide storage for over 8,000,000 gallons, is designed to meet the increasing consumption of petroleum products, particularly fuel oil, in Scotland.

The site, which has been leased from Granton Harbour Ltd., is on rising ground overlooking the Forth opposite the West Pier of Granton Harbour. Ocean tankers up to 18,000 tons are able to berth at the end of the West Pier from where the petroleum products are off-loaded by EMCO Marine unloaders and are pumped ashore through 10-in. and 12-in. diameter docklines, each between 4,000 and 5,000-ft. long, at rates of up to 2,000 gallons per minute. There are two types of storage—one for holding six million gallons of motor spirit, gas oils and kerosenes and one for holding two million gallons of fuel oil.

Owing to the limited space available for pipelines on the pier, it was necessary to install the light oil lines within the masonry pier itself. This particular part of the construction created the greatest problems as the laying of pipes from the ship to the shore entailed putting them through the existing pier structure. This turned out to be exceptionally hard work because the pier, which was in fact over a hundred years old, was a very substantially built stone structure and the local masons had made a very good job of it. The stone they used came from the local Granton quarries and they had further laced it with solid oak trenails. When the Oil Company's engineers came to investigate these, they found that although they were 100 years old, they were in remarkably good condition and required considerable exertion to be prised loose. After this had been done, the 10-in. and 12-in. dia. pipes had to be driven through the stone and then continued through the maze of piping already laid.

The fuel oil lines were placed one above the other on the inside face of the sea wall.

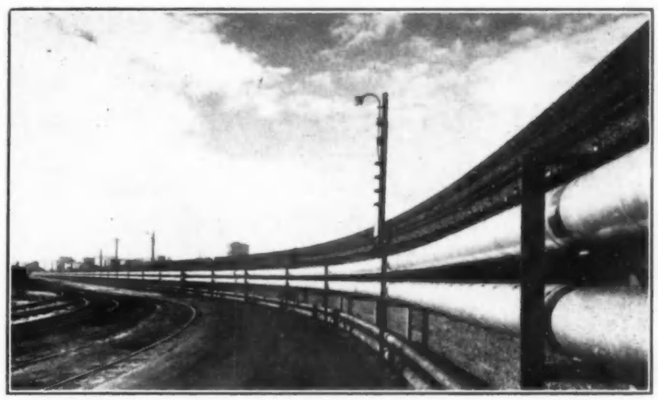
Handling Light Oils

The first delivery of light oils was made to the new terminal on April 25th last in the *M.S. Texaco Oslo*; with a summer d.w. of 18,810 tons she was the largest tanker ever to have discharged in Granton Harbour.

The light oil facilities comprise 14 vertical and 8 horizontal tanks accommodating three grades each of motor spirit and kerosene and two grades of gas oil. The light oil docklines inside the terminal run above ground into a selective manifold where the products are segregated into their own pipe system.

Light products are passed from the storage into road vehicles and railcars by 4 Mather and Platt centrifugal pumps operating at 600 gallons per minute and 4 more operating at 300 gallons per minute. The road tanker loading rack for light products has at present 18 filling points and has 6 loading bays, with provision for expansion.

All road tanker loading is recorded by a Gilbarco meter at each loading point. The meters carry a ticket printing head, thus providing an automatic record of the load.



Fuel oil lines (upper) along West Quay, Granton Harbour.

Three DRUM off-loading pumps working at the rate of 200 gallons per minute are available for pumping off the contents of road tankers as required. Delivery from these pumps is made through Gilbarco meters also with ticket printing heads which record the quantity pumped. A recently developed air stopping valve has been installed to safeguard against any entrained air upsetting the meters' accuracy.

Handling Fuel Oils

The storage and transportation of fuel oils presents a special problem in that they can only be handled at certain temperatures according to viscosity. If they are allowed to become cold they thicken, rendering them difficult to pump.

Such oils, therefore, have to be heated during transit in tankships and maintained in land tankage at temperatures at which they can be moved (pumped). Before they are loaded into road or rail tankers they are further heated so that they retain sufficient temperature to enable them to be discharged into users storage at the end of their delivery journey.

Three grades of fuel oil are stored at Granton in 6 vertical tanks, all of which are steam heated with internal "Fin-Tube Heaters." Both the heavy and medium oil tanks are insulated with glass fibre and clad with corrugated aluminium sheeting. The heat is generated by two Thompson Wilson boilers, raising

steam pressure at 4,000 lbs. per hour. The internal fuel oil pipe work and pipelines from the tanker pier are electrically heated and are also insulated with glass fibre and aluminium.

Drum pumps are used for all fuel oil movements, two pumps of 330 gallons per minute being allocated to each of the 3 fuel

Aerial view showing the layout of the new oil terminal at Granton Harbour.

oils. The pumps are remote controlled from the road or rail loading racks and are linked up through a differential pressure system which automatically calls into action one or two pumps in accordance with the demand from the loading racks. Delivery into road or rail tankers is by 4-in. articulated EMCO loading arms.

Layout

Considerable thought has been given to the layout of this terminal, with a view to providing economic operation facilities. The loading yard is approached from the harbour road up a hundred-yard slope, below the surface of which have been placed electrically heated mats to prevent icing during winter months. Acknowledgment is made to the Scottish Electricity Board whose advice and experience was made available to the Company's engineers.

The main buildings are constructed of brick and were designed by Regents Engineering Department in conjunction with the Edinburgh Corporation Planning and Architects Departments. They consist of an office and general amenities block containing messrooms, clothes drying and personal locker rooms, vehicle servicing and washing bays, general stores and a small laboratory. There is a large warehouse for storing and handling lubricating oils and greases in packages from 1 pint cans to 40 gallon barrels. A double-track rail siding extends into the terminal alongside which a rack has been built to provide for the loading of six railcars at a time. Railcars are moved inside the installation by electrically driven capstans. All main operating points of the terminal are inter-connected by an automatic internal telephone system. Owing to the position of the site, it was necessary to provide a 6-in. diameter water-main to supply the hydrant points for fire fighting. At each storage tank there are foam pourers and drenchers.

Terminal for Tankers at Khor-Al-Amaya

Description of Deep-Water Berth and Hose Handling Equipment

The Basra Petroleum Company Ltd., when faced with the problem of providing a deep water terminal for large tankers which could not be accommodated up-river at Fao, determined upon a piled structure located at Khor-Al-Amaya in the Arabian Gulf.

The new terminal, which is being constructed to the design of Rendel, Palmer & Tritton, Consulting Engineers, London, is sited about 20 miles from the shore, to which it is to be connected by under-sea pipelines carrying oil for export from Iraq. It is capable of accommodating simultaneously two supertankers of 65,000 d.w.t.

The terminal consists of a main centre island, approximately 400-ft. by 230-ft. linked by four 150-ft. span bridges, firstly to two large dolphins and thence to two end outer islands, one of which forms a tug berth and helicopter landing platform and the other an accommodation island. The overall length of the Jetty, which is sited in at least 70-ft. of water, is about ¼ mile.

At each of the two berths are being provided two oil loading booms, manufactured by Woodfield Rochester Ltd., which will be able to load a tanker at a rate of 7,000 tons per hour. Each pair of booms is operated by electro-hydraulic power, so as to present its four 12-in. dia. hoses to the manifold pipe connections on the tanker. When the hoses are connected and the crude oil is flowing the booms can be put into an automatic control condition when they can be left unmanned and will automatically luff, so as to follow the up and downmovement of the tanker with the tide.

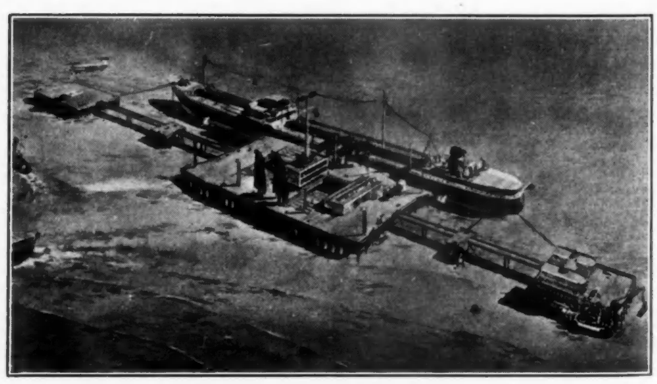
Technical Features of Loading Gear.

Each loading unit comprises a counterbalanced boom of all welded tubular construction pivoted upon a tubular column, the column being bolted securely to the Jetty structure at its lower end and provided with a ball bearing slew ring at its upper end, permitting the boom to be luffed within the range of 70° above horizontal to 40° below horizontal and to slew 55° either side of centre.

Under all condition, the boom is counter balanced so as to maintain a positive upward load at the boom head, and the luff motion is controlled by a wire line (deck line) arranged to anchor on the jetty deck via a return block.

To each unit there is a five drum winch positioned in the tail of the boom which operates 2 separate pairs of primary and secondary lines controlling the 2 flexible hoses and the "deck line" controlling boom luffing.

The slewing motion of the boom is powered by a separate electro-hydraulic mechanism, all motions being fitted with safety limit switches at ends of allowable travel.



Artist's impression of the new terminal.

The main crude oil transfer pipes comprise a 20-in. dia. riser within the main column, bifurcating into two 14-in. dia. tubes forming the outer lower members of the boom, converging at the head of the boom through swivel elbows from which are suspended the two 12-in. dia. smooth bore loading hoses, each 45-ft. in length, terminating in special swivel joint and elbows for

connections to the tanker manifold. The 20-in. riser pipe incorporates two stainless steel bellows joints to accommodate thermal expansion of the pipes, together with the ball bearing swivel joints to permit the luff and slew motions of the main flow pipes which also form the main structural pivots.

The loading units are designed to operate in pairs from a common control point located 40-ft. above jetty deck level, whilst duplicate controls are positioned at jetty deck level adjacent to the foot of the main columns.

Electrical controls within each console comprise, selector switches for each winch drum, joy stick controls for winch and slew motions, selector switch "Manual/Off/Automatic" together with lights to indicate winch drum or drums selected, limits tripped, supply on, motor overload, etc.

In use, after coupling the hoses to the tanker, the primary hose lines will be disconnected and the secondary hose lines free-wheeled, permitting the hoses to take-up an uninterrupted natural curve during loading operations.

The automatic feature comprises a series of flameproof switches operated by cams, the motion being transmitted to the cams from the tanker mainfold connection of the main hoses, via a nylon signal line tensioned in the boom by a spring reel. Movement of the tanker relative to the boom rotates the spring reel and operates the cams, which are arranged, under still conditions, to actuate the boom at every 6-ft. rise or fall of the tanker. Under conditions of 4-ft. rise and fall due to wave motion, the switches could therefore raise the boom with a 2-ft. nominal rise of the tanker. An electric winch is provided to initially tension the deck line and a warning light indicates the correct setting for switching from manual control to automatic.

The equipment is designed for a normal operational wind load of 7½ lbs. per sq. foot and special locks are provided between the boom heel and the main column to withstand gales of up to 120 m.p.h. velocity. These storm locks carry electrical switches to immobilise all motions whilst the locks are engaged.

One of the four twin 12-in. balanced boom loading units.

Special features of the equipment include the ease and simplicity of control, all motions having infinitely variable control, in forward and reverse direction up to the maximum speeds; the reduction in attendant man power required and the great attention paid to safety features including separate hydraulic "snubber" circuits which act automatically to hold the boom firm should a deck line break.

Single Point Tanker Terminal

The increasingly large size of tankers in service today poses many problems, not the least being the safe accommodation and expeditious handling of such ships in port. These problems are best solved by berthing tankers at properly constructed wharves or jetties in sheltered harbour waters, where the full range of port services, e.g. powerful tugs, experienced pilots, efficient cargo handling appliances, storing, water and crew recreational facilities is available.

The tanker "Maria Fassio" moored at the Miri single-point terminal.

Occasions sometimes arise, however, where crude oil has to be loaded or discharged, when it may be physically impossible or economically prohibitive, to provide sheltered berths and full port services. Hitherto, when these circumstances have arisen, multi-point moorings have been used, often a considerable distance off-shore, to secure tankers while they load or discharge their cargoes through submarine pipelines. Such systems, however, may have serious disadvantages in that they cannot provide ideal accommodation for various sizes of ships under all conditions of weather and tide likely to be experienced in an open seaway. Moreover, mooring and unmooring operations at conventional submarine line multi-point berths can be lengthy and subject to considerable tidal and weather restrictions.

For these various reasons, and to keep pace with the growing size of tankers, companies of the Royal Dutch/Shell Group began in 1953 to study the feasibility of operating single-point tanker loading/discharging terminals in open seaways. The concept was that, at such a single-point mooring, a ship could lie moored to a buoy by the bow only, her hull thus always presenting the line of least resistance to tide and weather forces, and could load or discharge her cargo through floating pipelines swivelled at the centre of the buoy and thence to the shore through submarine pipelines.

Extensive model tests were carried out in the Netherlands Ship Model Basin at Wageningen, in Holland, in 1957/1958, and these showed the concept to be theoretically sound. It was, therefore, decided to request Sarawak Shell Oilfields Ltd. to test a prototype at their Miri terminal, where crude oil has been loaded for a great number of years with tankers moored some three miles off-shore in conventional buoy moorings. As a testing ground, Sarawak was considered particularly suitable because the off-shore weather conditions there at times are such as to preclude ships from either mooring at or remaining in buoy berths of conventional

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Manufacturers' Announcements

Swing Bridge at West India Docks

A new swing bridge built for British Waterways and the London County Council to carry Narrow Street, Stepney, over the ship-lock entrance to Regent's Canal Dock, was opened last month. The new bridge will enable traffic passing between the City and West India Docks to use Narrow Street as an alternative to Commercial Road. Narrow Street has been closed to through traffic since 1955 when the old bridge, built about a century ago, was closed.

The bridge, which is 135-ft. long and 32-ft. wide, is designed for two lanes of traffic and weighs about 400 tons. It can be

The new swing bridge at Regent's Canal Dock.

swung into position in less than a minute and is the first of its kind in Britain to have its own system of Continental type road barriers and flashing warning lights. The barriers have vertical swinging booms with collapsible fringes. The bridge is controlled from a nearby tower and the whole operation from the flashing of the warning lights to the opening of the lock for shipping takes less than two minutes.

To overcome transport problems, particularly on the busy roads leading to the bridge site, the consulting engineers designed the bridge as an air-tight steel box and floated it from the contractor's Tees-side works down the east coast and up the River Thames to the dock entrance where the whole structure was lifted into position by Port of London wreck-lighters.

The control tower, situated at the western end of the bridge, gives the controller a clear view of the lock and its approaches and of road traffic on either side of the lock.

The bridge was designed by Husband and Company, consulting engineers, to the requirements of Mr. V. H. Tripp, Principal Engineer, British Waterways, and Mr. Joseph Rawlinson, Chief Engineer of the London County Council, Head Wrightson Teesdale Ltd. were the main contractors and the machinery was supplied by Sir William Arrol and Company Ltd. Foundations were undertaken by W. and C. French Ltd.

New Pilot Vessel for Belfast

Designed and built to the order of the Belfast Pilotage Authority at the Hampton Boatyard of John I. Thornycroft and Co., Limited, this vessel has recently successfully completed her trials on the River Thames. Named "Eleanor Laura" in honour of Lady Sinclair, the wife of Captain Sir Kenneth Sinclair, D.L., R.N.R., the Chairman of the Belfast Harbour Commissioners, the launch will operate from the shore-based Pilot Station established at Carrickfergus Harbour following the withdrawal from the station in Belfast Lough of the pilot vessel "Lady Dixon."

Built under Lloyd's supervision, the launch has an overall length of 54-ft., a 14-ft. beam and an extreme draught of 5-ft., and on trials she attained a speed of over 12 knots at which speed the range is approximately 375 nautical miles. The hull and decks are of single skin larch, whilst the keel, hog and stem are of English oak. Watertight bulkheads are of double skin African mahogany, each skin being $\frac{3}{8}$-in. thick. Aft of the forepeak, arranged as a chain locker, and aft of the store is accommodation for four pilots and one officer, the pilots having a large cabin with two single settee type berths, the backs forming the upper berths; and the officer's cabin is similarly fitted. Access from the wheelhouse to the pilot's cabin is by a mahogany stairway.

Two crew are accommodated abaft the engine room in settee berths, and on the starboard side is a well-equipped galley.

The aft peak houses the Whitlock marine steering gear and is entered through a watertight hatch in the deck. The combined chartroom and wheelhouse has been designed to give good all-round vision, there being 14 windows in all. Two Kent Clear View screens are fitted in the wheelhouse front, one on the starboard side in front of the helmsman and one on the centreline. Adjacent to the steering wheel are the engine controls, instrument

The Pilot vessel "Eleanor Laura."

panel and compass. On the port side is a large plotting table, at the fore end of which is the display unit for Decca River Radar equipment. Also fitted is a Pye VHF Marine Radio Telephone.

Careful consideration has been given to the arrangements for boarding the launch at sea. Handrails and stanchions are of robust construction and have been arranged to provide a good boarding area, and the side decks have been fitted with "safety walk" strips, produced by the Minnesota Mining Company. For protection when lying alongside the mast is mounted in a taber-

Single Point Tanker Terminal—continued

type. Sarawak Shell Oilfields Ltd. had also a highly experienced marine organisation to undertake the intensive testing programme required.

The prototype buoy, built by Werf Gusto, Holland, 27-ft. in diameter and weighs 65 tons is moored by eight 10-ton anchors and equipped to handle two grades of oil through three 12-in. floating pipelines. It was delivered in 1959 to Sarawak where, after extensive testing during 1960, it was decided to bring the buoy into operational service first as a bunkering/diesel oil loading berth, in order to get the widest experience of its capabilities for all classes of ships.

The experience on bunker service in the first half of this year indicated certain modifications to be desirable and the buoy was taken out of service in May and re-laid in June. It is now in service both for crude loading and bunkering and results so far are encouraging.

nacle and arranged to hinge aft and two substantial beltings have been fitted. The upper belting is carried with a Goodyear rubber fender. A ten-man inflatable life-raft is carried on the aft casing top. A hand-operated windlass is fitted for the vessel's anchors and cable.

The main engine is a Rolls-Royce marine diesel engine type C.6.TFLM fitted with a Capitol hydraulically operated gear and 2 : 1 reducing gears. It has a maximum rating of 300 b.h.p. at 2,000 r.p.m. A 24 volt, 900 watt dynamo is fitted to the engine and a single lever control operates both reverse gear and throttle.

The main engine exhaust system is a Rolls-Royce approved Thornycroft injection type with copper jacketted pipe and gun-metal injection fitting joining an end outlet type exhaust manifold on the engine. The main exhaust pipe is of reinforced rubber composition carried on the port side of the vessel to gunmetal outlet fitting at the transom. The auxiliary engine exhaust is of the dry type with steel pipes suitably lagged and carried to the outlet at the side of the launch.

Crane Controls for Amsterdam

Metal Industries (Europe) S.A., a company in the Metal Industries Group, has secured an order, through its office in The Hague, for the complete electrical equipment of eight harbour cranes for the Amsterdam Harbour Board. The contract, which is valued at nearly £50,000, calls for the supply of automatic control panels, motors and installation.

The control panels will be manufactured by Brookhirst Igranic at Bedford and the motors by Lancashire Dynamo and Crypto at Trafford Park. The cranes are being supplied by Krupp-Ardelt, Wilhelmshaven, Germany.

The Amsterdam Harbour Board has already installed a large number of cranes equipped with Brookhirst Igranic controls. These cranes replaced those destroyed during the war.

New Grain Handling Plant for South Africa

A new model of a self-propelled, self-powered grain handling plant has been developed by Simon Handling Engineers, Ltd. of Stockport, Ches. It can be employed on a variety of grain handling operations at rail, road and dock transfer points and has a capacity of 37½ tons of grain per hour.

The pneumatic handling equipment is mounted on a Leyland Beaver chassis powered by a Leyland 680 six-cylinder 150 h.p. diesel engine, and is driven from the vehicle power take-off unit through a turbine gears reduction unit. The conveying air stream is provided by a Roots-type exhauster mounted centrally on the vehicle platform. The grain is conveyed under suction from the vessel or vehicle being unloaded into a large grain receiver mounted near the rear of the vehicle. Here the grain falls out of suspension, while the air is drawn through a cyclone dust collector. The air is cleaned further in an air receiver on the suction side of the exhauster. The grain and dust are discharged from the receiver through a rotary seal which preserves the vacuum, into a delivery pipe through which they are blown to their destination. The total distance over which the grain can be conveyed is 150-ft. and this can be divided into suction and blowing lines of equal or varying lengths to suit the circumstances.

The first plant of this type was despatched recently to South Africa for use by the East London Stevedoring Company.

P.L.A. Crane Order for Holland. Holland Cranes, The Hague, has received an order, valued at over four million guilders, from the Port of London Authority for a 60-ton self-propelled floating crane. Partners in the Dutch firm are Conrad-Stork, Haarlem, Verschure and Co's Scheepswerf and Machinefabriek, Amsterdam and Werf Gusto v/h fa A.F. Smulders, Schiedam.

New Facilities for Ferry Traffic at Preston Docks

A large tied-portal type standard steel building, 280-ft. in length with a clear span of 100-ft. and eaves height of 35-ft., has been supplied and erected at Preston Docks, Lancashire, for Anglo-Continental Containers' Services (London) Ltd. and (Belfast) Ltd. by Sanders and Forster Ltd. of Barking, Essex.

The building will be used as a dockside warehouse and transit shed for the assembling and distribution of the multiple container loads used in the "door-to-door" container service operating between the United Kingdom and Northern Ireland. It is clad in asbestos cement sheeting and is well provided with natural lighting from 6-ft. deep strips of continuous glazing immediately below the eaves and also from over 225 translucent roof lights.

View of new transit shed with travelling gantry crane extending out to quay.

To interrupt as little as possible the busy day-to-day activities of Anglo-Continental Containers' Services, the shed was erected on the dockside in two phases. The first stage incorporated the erection of a 120-ft. long building, which partly enclosed an existing free standing overhead travelling crane gantry operating between ship and depot, and the second step was to demolish an old existing building and to extend the new building to its complete length of 280-ft. During this period the existing crane gantry was also extended to accommodate two 15-ton travelling cranes.

Sanders and Forster Ltd., who are the structural engineering company of the Chamberlain Group of Companies, manufacture standard steel buildings. Their range consists of five distinct types, each covering a wide range of spans and heights and catering for every requirement and purpose. The main structurals and components for such buildings are produced in a semi-automatic fabricating plant, which was one of the first to be installed by structural engineers in Great Britain and which, by eliminating costly manhandling, permits quick deliveries and low costs.

Materials Handling Equipment (Great Britain) Ltd.

Materials Handling Equipment (Great Britain) Limited, 40a Dover Street, London, W.1 and Maidenhead, Berks, announce that, in order to meet demand for their well-known Kestrel and Falcon Side Operating Fork Lift Carriers, and Lizard Electric reach trucks in both Home and Overseas Markets, and to provide for further development of the present and additional models, the Parent Company, Hunslet (Holdings) Limited, is to allocate greater facilities. Consequently production and key personnel have been transferred from Maidenhead to the Hunslet Engine Company at Jack Lane, Leeds. The London and Maidenhead Offices have been merged with the Hunslet Group at Locomotive House, 30/34 Buckingham Gate, London, S.W.1.

New Collapsible Transport Pallet

The advent of the forklift truck and pallet method of materials handling has necessitated a new approach to goods movement whether in factory or by road, rail, sea or air.

Efforts have been made to cut down the numerous designs of pallet that were first introduced and standardisation of the many factors involved has reduced the number of pallet types required, except in specialised circumstances.

E. Stephens and Son Ltd. have now introduced a standard form of collapsible post or box pallet (Patents Pending) that has a number of interesting features. It can be supplied to any size requirement and yet, in its collapsed form has an approximate height of only 8-in. thus conforming to railway return travel requirements. They can also be stacked with any other makes of pallet. The link-joints which allow the permanently attached "posts" to collapse, are of such robust character that the posts (which can be square or round), are held sufficiently rigidly in their erected state so that they need no form of bracing at all.

The detachable sides, which can be mesh or sheet, are easily and quickly removed, replaced or exchanged and although there are no buttons, screws or catches involved, there is no possibility of their coming adrift in the collapsed position.

Further details of this transport pallet may be obtained from E. Stephens and Son Ltd., 58/66 Bath Street, London, E.C.1.

V.H.F. Radio-Telephone Equipment for Bosphorus Ferries

Nine passenger ferries, each 210-ft. long (B.P.) with a speed of 15 knots, for service on the Bosphorus and Sea of Marmara, built for Denizcilik Bankasi T.A.O. Instanbul at the Clyde shipyard of the Fairfield Shipbuilding and Engineering Company Limited, are being equipped with V.H.F. radio-telephone equipment designed and manufactured by Cossor Communications Co. Ltd., Stanmore, Middlesex.

The equipment, Cossor Type 124ME28 V.H.F. radio-telephones, provides for instant selection of any channel required for communication within the 28 channel International Marine Band, and can be used for ship communications in connection with port operations, intership working and public correspondence as required. Each equipment consists of a transmitter-receiver with built-in power unit, control unit and loudspeaker.

Cutter Suction Dredgers for Malaya

Following their announcement in last month's Journal of an order secured to build a salvage tug for the Port of Calcutta, Simons-Lobnitz have now announced that they have received an order for six cutter suction dredgers from the Drainage and Irrigation Department of the Government of the Federation of Malaya. This new order, placed through the Crown Agents for Overseas Governments and valued at almost £250,000, was secured in competition with American and European yards.

The dredgers will be 45-ft. in length between perpendiculars, 20-ft. in moulded breadth and 5-ft. in moulded depth, their hulls comprising a number of pontoons on which all the machinery will be mounted. They will be non-propelled and easy to dismantle and transport. They will be capable of dredging to a depth of 20-ft. below water level and their Rolls-Royce pumping engines will be capable of pumping to a distance of 1,200-ft. and to a heighth of 10-ft. above water level.

The second Malayan Five-Year Plan recently announced includes some £11½ million for drainage and irrigation works and one of the main tasks of these dredgers will be to deepen rivers in areas which suffer from flooding, thus making much valuable land available for agriculture.

Cutter for London Port Health Authority

The motor vessel "Humphrey Morris" launched last July at the Faversham shipyard of James Pollock Sons and Co. Ltd. is to be the flagship of the Port of London Health Authority's fleet of motor cutters and has been specially designed to their requirements. She has a length overall of 97-ft. 5-in.; length on waterline of 87-ft.; a moulded breadth of 21-ft.; a moulded depth of 9-ft. 6-in. and a draft aft of 7-ft. 6-in.

The flared stem of the vessel has a built-in Firestone fender of 8-in. solid section rubber, and the bulwarks forward have been raised to a height above normal practice to deal adequately with the choppy waters of the Thames Estuary. The eliptical cruiser stern has a semi-balanced rudder. She has been built to Lloyd's highest classification for the duties involved and in some cases, the scantlings are heavier than those required by Lloyd's. The whole of the superstructure is of aluminium.

The doctor's accommodation forms the major part of the deckhouse forward and consists of a consulting room with adjacent cabin. Opposite is the navigator's cabin and below deck the engineer's cabin, officers' saloon and the crews' mess. At the rear of the deckhouse is the hospital, equipped for two stretcher and three sitting cases. There is central heating and forced ventilation throughout the vessel.

The main engine is a Ruston and Hornsby 5-cylinder diesel engine developing 655 b.h.p. at the gearbox output coupling at 500 r.p.m.